JUL 30 1943

The Engineer

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PLANT FOR HAMMER DRIVEN PILES

(A) Mobile outfit for undulating sites.
3 ton Drop Hammer.

(B) Mobile outfit for small contracts.
2 ton Drop Hammer.

(C) Frame, working with 14′ 0″ headroom.
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Used with A, B, & D type outfits.

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Piles can be driven to any depth up to 100′ 0″ and mandrels made up to suit.

15½″ and 17½″ diam. Shells, 3′ 0″ long. | 14½″ diam. Shells, 4′ 0″ long.

← Solid Concrete Shoe →

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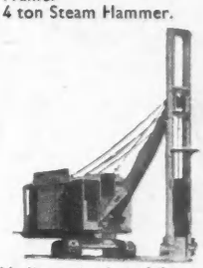
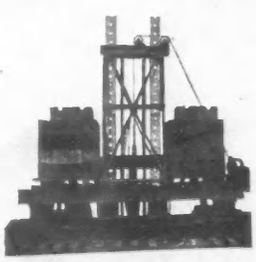


(E) Medium sized mobile outfit.
3 ton Drop Hammer.

PLANT FOR "OXFORD" PRESSURE DRIVEN PILE

This pile is pushed down without Vibration!



The Kentledge load tests each and every pile

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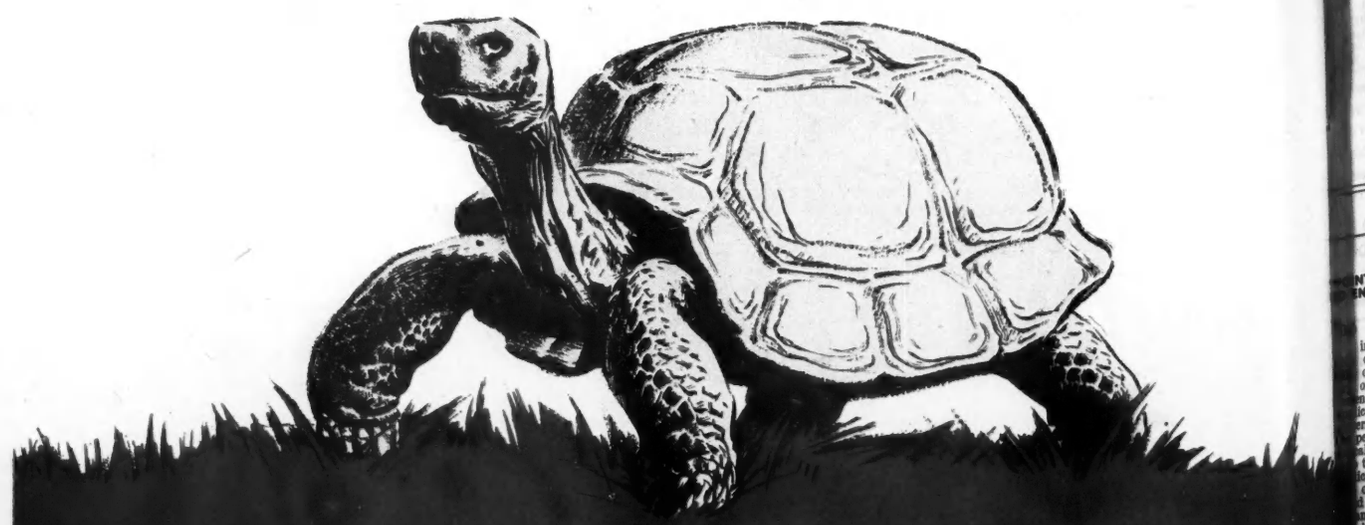
LONDON OFFICE: COLUMBIA HOUSE, ALDWYCH, LONDON, W.C.2
SCOTTISH OFFICE: 2, WEIRWOOD PARK, BAILLIESTON, NR. GLASGOW. Telephone: BAILLIESTON 52



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The Engineer

LONDON, FRIDAY, JULY 9, 1943.

PUBLIC NOTICES

CITY OF SHEFFIELD

NTMENT OF GENERAL MANAGER ENGINEER OF WATER UNDERTAKING

Sheffield City Council invite APPLICATIONS for the APPOINT- of GENERAL MANAGER and ENGI- of the WATER UNDERTAKING, at a of £1500 per annum, rising by annual nts of £50 to £1750 per annum. licants must be qualified Civil and Water ers.

person appointed will be required to pass al examination and devote the whole of his the service of the Council.

lications must be made on the official form, obtained from me and to which are the terms and conditions of the appoint- nd must be addressed to and received by later than the 31st July, 1943.

sassing or any communication to a member Council, either directly or indirectly, is ted, and will be a disqualification.

JOHN HEYS,
Town Clerk.

n Hall,
Sheffield, 1,
8th July, 1943. 8013

THE INSTITUTION OF GAS ENGINEERS

Institution of Gas Engi- NEERS INVITES APPLICATIONS, not han 26th July, 1943, for the APPOINT- of ASSISTANT SECRETARY, at a ncing salary of £700 per annum. Con- from the SECRETARY, The Institution Engineers, 1, Grosvenor Place, London, 9082

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ther particulars regarding the appointment e obtained on application to the under- with whom applications should be lodged ter than 4th October, 1943.

ROBT. T. HUTCHESON,
Acting Secretary of University Court.

, 1943. 8015

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EDUCATION DEPARTMENT

V COLLEGE, SCHOOL OF ENGINEERING 6, Shamrock Street, Glasgow, C.4)

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plete courses are provided, including nical and Electrical Laboratory Work. School has been approved by the Ministry sport for the training of Marine eers, and, being so recognised, attendance School will be accepted by the Ministry in of qualifying sea service.

ther particulars and prospectus may be on application to the Director of Education, Bath Street, Glasgow, C.2, or to the ipal of the School.

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ctrical Engineering: Professor M. G. SAY, , M.Sc., A.M.I.E.E.

rance Examination for those not otherwise ified for admission, 21st and 22nd September. e Scholarships, value £35 per annum, are ed on the results of this Examination.

SSION BEGINS, MONDAY, 11th OCTOBER. rospectus sent free on application.

J. CAMERON SMAIL,
Principal.

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The Engineer

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BABCOCK & WILCOX LTD.

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THE FACT that goods made of raw materials in short supply owing to war conditions are advertised in this paper should not be taken as an indication that they are necessarily available for export.

PUBLIC NOTICES

TO ENGINEERING SOCIETIES, TECHNICAL COLLEGES, ETC.

We Offer the Services of a TECHNICAL LECTURER on subjects of interest to Mechanical and Production Engineers, to Engineering Societies, Technical Colleges, Production Groups, and similar bodies now making up their Winter Programmes.

The talks were originally devised for the Mutual Aid Groups sponsored by the Ministry of Supply, and have been given to about fifty of these and similar Groups.

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Write to SPEAR and JACKSON, Ltd., Aetna Works, Sheffield, for full particulars and vacant dates. 9973

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For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

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Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1941 No. 2069

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APPLICATIONS are INVITED from Highly qualified ENGINEERS for APPOINTMENT to a POSITION of RESPONSIBILITY in a well-known firm engaged on work of high importance. Candidates must have had first-class education (degree) and thorough practical training in Engineering. Management experience, embracing at least five years' experience in modern production methods, also essential. Age limits, 30-40 years. The vacancy carries high salary and excellent peacetime prospects. Only candidates of highest calibre and integrity considered. Write in confidence.—Address, 9997, The Engineer Office. 9997 A

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THE Post You Are Seeking May Not Be Advertised in this Column, but do not lose the Opportunity of Bringing your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for the cost of Four Lines, 6s.; 1s. 6d. for each Additional Line. There is no better way of covering so large a field for such a small charge.

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The Engineer

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***Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of* THE ENGINEER.**

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Teleg. Address,
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Tel., Central 6565 (10 lines).

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THE PROPRIETORS of BRITISH No. 411,321, relating to "Impro in or relating to Molybdenum Steels," to ENTER into NEGOTIATIONS with more firms in Great Britain for the SALE PATENT RIGHTS or for the GRA LICENCES to MANUFACTURE under Inquiries to be addressed to D. YOU CO., Chartered Patent Agents, 29, South Buildings, London, W.C.2.

THE PROPRIETORS of BRITISH No. 478,048, relating to "I Apparatus for Uncoiling Sheet Meta DESIROUS of ENTERING into AR MENTS by way of LICENCE or other reasonable terms for the purpose of EX ING the same and ensuring its full deve and practical working in this co Interested parties who desire a copy Patent Specification and further pa should apply to ARTHUR W. PAR Stafford House, Norfolk Street, London,

THE PROPRIETOR of BRITISH No. 504,617, dated October 24th relating to "Geophysical Prospecting Apparatus," is DESIROUS of ENT into ARRANGEMENTS by way of a L or otherwise on reasonable terms for the of EXPLOITING the above PATENT and its practical working in Great B Inquiries to SINGER, EHLERT, STE CARLBERG, Steger Building, Chicago,

THE PROPRIETOR of BRITISH No. 505,241, dated March 29th, 19 ing to "Improvements in and connec the Making of Pistons," is DESIRO ENTERING into ARRANGEMENTS by LICENCE or otherwise on reasonable te the purpose of EXPLOITING the PATENT and ensuring its practical wor Great Britain.—Inquiries to SINGER, E STERN and CARLBERG, Steger Chicago, Illinois.

For continuation of Small Adve ments see page 4

A Seven-Day Journal

An Army Equipment Exhibition

ON Tuesday, July 6th, the Quartermaster-General, General Sir Thomas S. Riddell-Webster, officially opened an Exhibition of Army Equipment on the bombed site of John Lewis, Ltd., in Oxford Street, London. The Exhibition has been designed to illustrate what our war industry is actually producing for the Army, and to point out the complexity of the needs and how vastly improved are the conditions for the private soldier as regards his food, personal equipment, and hospital services, &c. The area of the Exhibition covers some 100,000 square feet, and the value of the items illustrated is about £100,000. One of everything needed fully to equip a Division is on view. The Exhibition was arranged by the Ministry of Information for the Army Council. Although some 23,500 different items of equipment are displayed, they only represent a fraction of the 3,500,000 different items which are supplied to the Army by the Quartermaster-General at a cost of £3,000,000 a day. Among the exhibits which will be specially interesting to engineers is the 84ft. span "Inglis" sectional bridge, which is designed to take a load of 30 tons. Other bridges are those employed by the Army for crossing water, and they include a 48ft. span box girder bridge, a trestle bay, and pontoon bridges with "Kapok" floats. Various types of Army boats are also on view. The transport and fighting vehicles include, besides a "Valentine" tank, different patterns of Lloyd and Bren gun carriers, armoured cars, and an armoured Command vehicle. The guns include the famous six-pounder and the twenty-five-pounder which played such an important part in the Libyan and Tunisian campaigns. Various types of ovens and field kitchens are illustrated, and another section shows the Clarkson "Thimble-Tube" oil-fired boiler, as applied to the heating of water for the mobile bath units and providing steam for the larger mobile laundry units, which are complete with a Broadbent centrifugal dryer and washing machine, an Armstrong drying tumbler and drying cupboards, and an Austin generating set. Various types of air compressors and generating sets are on view.

Railway Wages

A FURTHER meeting between representatives of the Railway Executive Committee and the trade unions concerned took place in London last Friday week, when negotiations were continued on the subject of the union's claim for an advance of 10s. per week for more than 100,000 railway shopmen. No settlement was arrived at, and the conference was adjourned for a further meeting of the Railway Shopmen's National Council. The meeting, it is understood, was called in response to a request received by the Railway Executive Committee from the union. We understand that an offer was made by the Railway Executive Committee, but it was not accepted. Negotiations, it is pointed out, have not broken down, and a further joint meeting will probably be arranged after the offer has been discussed by the Union's National Council. Another announcement has been officially made concerning a wartime advance for the staffs of railway companies. It states that the railway companies have agreed that a war advance at the rate of £53 6s. a year shall be paid to all staff who are in receipt of salaries ranging from £500 to £1000 a year. At the National Union of Railwaymen's conference, which took place at Carlisle during the early part of this week, there was some criticism of the recent 4s. 6d. increase for adult railway salaried staffs and traffic grades, which was recently granted by the Railway Executive Committee. On Tuesday a resolution was passed at the conference which favoured the national ownership and control of all transport. Speaking on that subject, Mr. J. Benstead, the general secretary of the union, said that reform would be necessary after the war in order to secure for Britain the maximum amount of internal and external trade. In his opinion, Government control should not be lifted from the railways until there was a clear determination of what was going to happen to British railwaymen. The nationalisation of the whole means of transport, including rail, road, sea, and air transport, was not, Mr. Benstead agreed, going to be an easy matter. He looked forward to further railway electrification and railway interest in air transport. All this would affect the future of the railway workers.

Air Losses During the War

THE Ministry of Information has recently issued an official record of aircraft lost since the beginning of the war up to the end of June, 1943. The analysis shows that, whereas the total losses of Axis aircraft on British fronts were 18,031 machines, the combined losses which have been sustained by the Royal Air Force and the United States Army Air Force in Europe were 9906 machines. A table which accompanies the analysis shows that over Great Britain, from 1939 to June, 1943, the Axis lost 4201 aircraft and the R.A.F. 900. Over Europe the figures were 1857 and 5357 respectively. The figures for the Middle East, which include Malta's successes against the Axis—1940, 44; 1941, 238; 1942, 915; and 1943, 74, making a total of 1271—show that the Axis lost 3500 machines and the R.A.F. 1977. The Tunisian 1942 and 1943 figures, which are for the North-West African Air Force and not the R.A.F. alone, show Axis losses of 2231 and R.A.F. losses of 795 aircraft. For the Far East, India, and Burma figures for 1942 and 1943 are:—Axis, 4042; and R.A.F., 149. For the Western Front during 1939 and 1940 the losses are:—Axis, 857; and R.A.F., 379. In Scandinavia the Axis lost 56 aircraft in 1940 and the same year the R.A.F. lost 55. The figures for the R.A.F. wing serving in Russia for 1941 show Axis losses of 15, with one R.A.F. loss. In the case of the United States Army Air Force machines operating with the R.A.F. over Europe the figures for the years 1942 and 1943 are:—Axis, 1172 machines; and R.A.F., 293. From these figures the aggregate totals of 18,031 Axis and 9906 R.A.F. machines, previously quoted, are obtained. The Axis losses also include 985 aircraft which so far have been announced as destroyed by the Royal Navy. This figure is not yet complete, and no returns are so far available with regard to the German losses to the French and the Russians. As regards the American losses in the Far East, no particulars of these losses have yet been published.

A Review of Production

IN his postscript broadcast on Sunday evening, July 4th, Mr. Oliver Lyttelton, the Minister of Production, reviewed the problems of production in this country and America, and said that we had to redouble our energies for the making of new weapons, which would of necessity mean the shifting of production from one point to another. At the present time, he said, we were going slow on many of the munitions which were used by the Army, because we had them in abundance and it was necessary still further to increase our production of ships and aircraft. He went on to describe the two-way working of the lend-lease principle, and spoke of the help we had received from the United States, our assistance to the American Forces in this country, and the British and American help which was being given in increasing strength to our Russian Ally. Looking over the whole field of war production, naval and other shipbuilding, Army, munitions, and aircraft, it could be said that the production of the British Commonwealth was now larger than that of Germany, Austria, and Czechoslovakia put together. The Axis could now calculate how the production of Italy, Japan, and the occupied territories compared with the vast output of the United States and Russia. They could derive what satisfaction they liked from that chastening thought. Speaking on the time lost in factories, Mr. Lyttelton said that such was the resolution and patriotism of our men and women, many of whom had been taken from their homes and had been sent to far distant factories, that we had lost in the last twelve months from industrial disputes less than one hour of each worker's time in the whole year. As a direct result of clothes rationing more than 500,000 workers had been released for other work, while the concentration of industry had freed another 250,000 for new tasks. We were now living on less than half the imports which we received into our country in a normal year before the war. That meant millions of tons less shipping, with its saving of ships and sailors' lives. As to working hours, we were now working the longest hours which could be endured. In the munitions industries the average hours worked each week by men had exceeded fifty-five and by women had exceeded fifty. If our workers in the factories were obliged to work for longer hours he felt that their output would not go up.

First Atlantic Flight of Freight Glider

ON Monday, July 5th, it was revealed by the Air Ministry that a fully laden glider had been successfully towed across the Atlantic Ocean for the first time. The journey was made from Montreal to a British port, and the distance of 3500 miles was accomplished in a flying time of 28 hours. The glider had a wing span of 84ft., and it carried 1½ tons of cargo, which included vaccines for Russia and spare parts for radio equipment and aircraft and engines. The cargo hatch is arranged in the form of a hinged door in the nose of the machine. The towing rope is of "Nylon" costing close upon £80, and it is designed along with its steel attachments to withstand a pull of 20,000 lb. On the trip from Montreal to Britain the weather conditions were on the whole favourable, except at the start when a head wind made progress extremely slow. The aircraft which towed the glider was a twin-engined "Dakota." It was piloted by Flight-Lieut. W. S. Longhurst, R.A.F., as captain, with Flight-Lieut. C. W. H. Thomson, and Mr. H. G. Wightman as radio officer and Pilot-Officer R. H. Wormington as flight engineer. The glider was piloted by Squadron-Leader R. G. Seys, D.F.C., R.A.F., who acted as captain, and Squadron-Leader F. M. Gobeil, of the R.C.A.F., as co-pilot. An interesting modification was made to the towing aircraft for Atlantic flying conditions, special fuel tanks being fitted, which in an emergency could be jettisoned intact, thereby avoiding the possibility of loose petrol being sprayed back on to the glider, which could be ignited by atmospheric electricity. The glider was built in America. The original idea of a Transatlantic freighter "train" was conceived by Air Chief Marshal Sir Frederick Bowhill, the A.O.C.-in-C. of R.A.F. Transport Command, who, while in charge of the North and South Atlantic Bomber Ferry from Canada, began the experiments for a Transatlantic glider service for freight traffic.

The Reopening of Jarrow Shipyards

ON Tuesday, July 6th, Mr. G. H. Hall, the Financial Secretary to the Admiralty, paid his long-promised visit to Jarrow. It will be recalled that some time ago a deputation from Jarrow waited on the Admiralty and pressed for the reopening of the Jarrow shipyards. On that occasion Mr. Hall promised to visit Jarrow, and that he has now done. His visit and his inspection of the old Jarrow shipyard should, he felt, not be taken as an indication that there was a likelihood of the yards at Jarrow being reopened in the near future. Should such an impression gain ground, it would do a great disservice both to Jarrow and to Tyneside. Nine months ago the Admiralty had considered the question of the reopening of some of the shipyards, but since that time the position had changed. In the main, manpower and machinery equipment were the largest difficulties. He felt that it was quite right that the local authorities at Jarrow and other local authorities on Tyneside should press their claims. He said that he could assure them that should the question of reopening shipyards come up again, then both Jarrow and other places would receive careful consideration.

Engineers and the British Empire

By Professor MIDDLETON SMITH, M.Sc., M.I. Mech. E., LL.D.

No. II—(*Continued from page 3, July 2nd*)

THE INDUSTRIAL REVOLUTION IN CANADA

IT must seem to the engineer who studies carefully the physical conditions and the natural resources of Canada that there is hardly any other country in the world where there have been, and are, such splendid opportunities for the application of his work. For the Dominion offered wonderful prospects for the transformation of empty waste spaces into fertile and populated areas, for the recovery of mineral wealth, for the utilisation of immense water power, for the construction over most difficult routes of facilities for mechanised transport, and for the building up of a great industrial civilisation in one of the most loyal portions of the British Empire.

The story for some centuries of the early days of colonisation was predominantly a story of agricultural development, but in comparatively recent years a great industrial revolution has taken place. Although, during the past fifty years, every progressive country in the world has developed its industries, it is doubtful if any other has changed so rapidly from an entirely rural to a great manufacturing nation. Agriculture still remains important, but mechanisation has immensely increased the areas under cultivation and has provided many amenities of life, such as electricity, motor vehicles, and radio for the farmers. But the remarkable development of industries dependent upon the supply of power is the outstanding feature of the country.

When Cartier arrived in the St. Lawrence in 1535 he found fields of maize where the City of Montreal now stands; the first activity of the French settlers was to cultivate the land. Wheat became one of the most important products of the country, but there has also been built up a great industry in connection with the canning of meat, fruits, &c., which entailed mechanisation. Flour milling was one of the earliest industries, and in this century it has developed enormously.

The first cotton factory was erected in 1844, some 1200 spindles being used. The introduction of steam-driven machinery enabled a large cotton centre to be established nearer than England to the raw material; the demand for machinery increased the demand for coal and iron. Progress was very slow, for the great need of the country was a larger population. It was the opening up of Western Canada by the railways that caused the great transformation in the provinces served by them. Mines were discovered and cheap hydro-electric power generated. Large steel plants and rolling mills were installed. An important factor favouring industrialisation has been cheap inland water transport. Thus Ontario furnaces use local ores but American coal, which can be carried to the ports on the Great Lakes cheaper than Canadian coal. Iron is found in large quantities in Canada; it is widely distributed, but the development of mines was retarded because of the import of higher grade ores from Newfoundland and the United States.

The low-grade ores must be concentrated by roasting before they are suitable for blast-furnaces. Great hopes have been expressed that cheap power would permit the iron and steel industries to expand by adopting electric smelting, but the electric furnace has as yet been unable to compete with the ordinary furnace.

The chief coalfields in Eastern Canada are north-east of Cape Breton. They are operated by the British Empire Steel Corporation, which imports ore from its mines in

TYPICAL RAPIDS ON CANADIAN RIVER

ST. MARY RIVER HYDRO-ELECTRIC PLANT, ONTARIO

Newfoundland and produces pig iron and steel. There are large coalfields in Alberta and British Columbia, but owing to cheaper transport a great deal of coal is imported from the United States.

The history of engineering in Canada reveals as a prominent feature the relative lateness of transport facilities, and the slow progress of mechanisation, as compared with that of the southern neighbour.

The much colder climate, the comparative failure of early colonisation, and in the period of French control—up to 1760—colonial misgovernment were factors retarding progress. In 1763 Canada had a population of less than 70,000, while that of the English Colonies in the south was 3,000,000. For a period the population of the United States was rapidly increasing, while that of Canada remained almost stationary, but in recent years the percentage increase in population in Canada has been the greater.

The development of railway transport to the west from the Atlantic coast came from three to five decades later in Canada than in the more southern latitudes. In the manufacture of the basic needs of mechanised civilisation, such as iron and steel, the United States progressed much more rapidly.

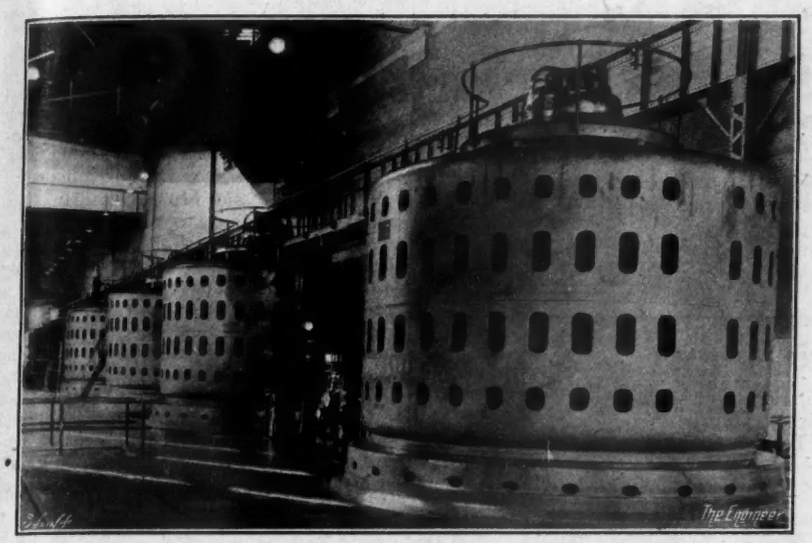
The period of British control, when each province in Canada had a separate Government (1760–1867), was a time of great industrial progress in Britain, for it was then that England earned the title of "The Workshop of the World."

America at first lagged behind England, for there was the attraction of the sparsely populated, fertile, and huge areas of land to be exploited in the interior and western portions of the United States. In Canada the physical conditions were more difficult. The large number of loyalists, who emigrated into Ontario, after the American War of Independence, created a prejudice against intimate relations with the neighbour, but the crude methods of transport were also a factor in separating the inhabitants of the two adjoining countries.

Engineering developments in Canada lagged behind those of the United States, because the Federal Government of the latter country secured a uniformity of national policy that the unfederated provinces, the vigour of provincial strife, and the conservative French-Canadian element in Quebec Province checked in Canada.

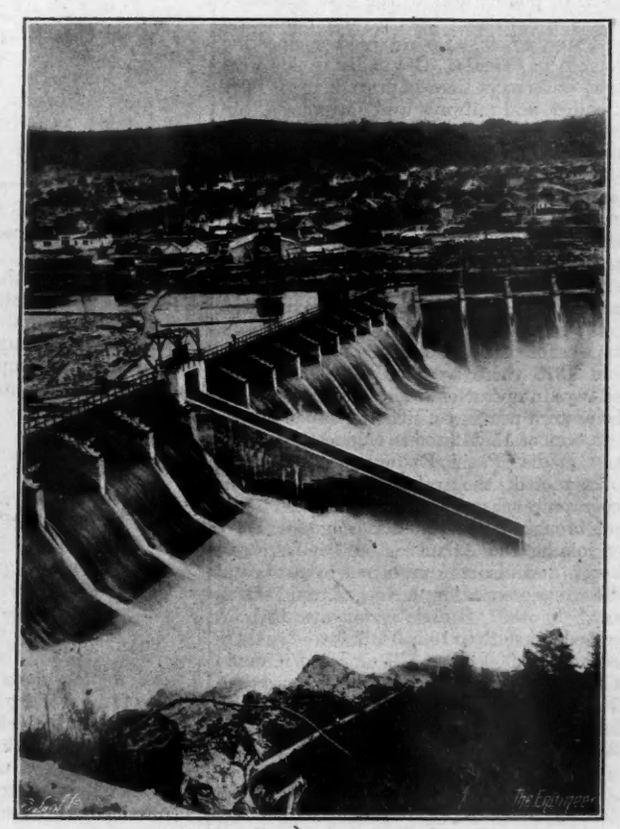
The more progressive English settlers found progress in Ontario retarded by the American tariffs, the distance from European markets, the ice on the St. Lawrence during the winter months, and the control by the Quebec provincial authorities of the export and import trade along the lower reaches of the St. Lawrence. The Quebec authorities remitted only a small portion of the Customs duties on imports and exports to Ontario, which was the equivalent of a toll on all goods passing to and from the west. Tariffs and national prejudices may for a time restrict the exchange of commodities, but efficient transportation is the keystone in the arch which supports commercial intercourse between nations. The agricultural, mineral, and forest wealth of Canada could not be developed without great improvements in transport.

The British Government, anxious to pro-



GENERATORS AT NIAGARA HYDRO-ELECTRIC PLANT

KICKING HORSE CANYON



POWER PLANT AT POWELL RIVER, B.C

mote world trade, finally persuaded the several provinces to agree to have one Government for the whole country, and federation took place in 1867. It was the shadow that went before the coming event of Dominion status, attained rather more than fifty years later.

THE GREAT CANADIAN WATERWAY

In the early years engineering work in the country suffered from a lack of available capital. Many of the settlers were poor, and Canadians—especially the French element—preferred hoarding in homes to investment in banks or industrial projects. British financiers were alarmed by early losses in Canada, and they turned to the United States, which seemed to them to offer better prospects, and where the development of railways and industry demanded more money than Americans could supply. The influence of British capital, and of British engineers, in the early development of mechanisation in the United States and in Canada is worthy of note, for it accelerated the prosperity of both countries.

The lack of coal, then about the only source of power, near to the manufacturing centres, a deficiency later greatly minimised by water power, also retarded engineering progress in Canada. Gradually canals were built, waterways were improved, roads were extended, and railways were introduced. In 1850 there were only 66 miles of railways in Canada!

Although the waterways afforded the only route of travel in the early days, obstacles, such as rapids and waterfalls, had to be circumvented; canal construction was the only means of doing so. To-day the inland waterways, on some of which I have travelled, provide a speedy, and relatively inexpensive, method of transport for freight and a pleasant journey for passengers not tied by time.

In 1875 there were only 4800 miles of railways in operation. These were mostly in the eastern provinces. The triumphant construction of that famous engineering work, the Canadian Pacific Railway, in the eighties counteracted the retarding influence of geographical characteristics, stimulated trade, and brought about greater economic unity by joining the Atlantic and Pacific ocean shores, and also the maritime, central, and western provinces, by means of rapid transport. In 1897 Canada's railways had increased in length to 16,550 miles; to-day there are over 40,000 miles. The area of Canada is 3,694,863 square miles, which is more than 27 per cent. of the total area of the British Empire. The area of the British Isles is 121,633 square miles.

Mechanisation in Canada

In the modern world production in any industry has been affected by national policy, such as tariffs and subsidies. The development of the Canadian iron and steel industries was affected by the political action of the Government of Canada and other nations. The organisation and integration of the industry into the United States Corporation, across the border, profoundly affected Canada.

The most rapid growth in the iron and steel industry has taken place since 1897, a period of gradually reduced protection. Then, up to 1913, the annual consumption of pig iron was about twelve times as much as in 1896, and Canadian blast-furnaces supplied on the average about 80 per cent. of the demand, as compared with an average of 30 per cent. in the period from 1884–92, and 60 per cent. from the period 1893–1900. The demand for steel had increased from about 20,000 tons in the 1890s to about 1,000,000 tons in 1913, when more than 90 per cent. was made in Canada.

Nova Scotia developed an iron industry because of the unlimited supply of iron ore of a satisfactory quality and an unlimited supply of coal at places to which the ore can be carried cheaply.

In recent years there has been an immense development in mechanisation in the timber, pulp, and newsprint industries, and also in the production of metals, especially of nickel—also aluminium—made possible by cheap hydro-electric power. Nor must we overlook the great volume of engineering work connected with water power development.

We know that, since 1939, Canadians have made strenuous efforts to make their country an arsenal for the British Empire. They can claim that, for that purpose, it is second only to Great Britain. For security reasons it is not possible to describe many of the engineering works that have been carried out since 1939; but it is safe to say that the many airfields, the increase in power production and mechanisation, and the work, not only of Canadians, but of British and American engineers, in these recent strenuous years, has immensely increased the development of the natural resources of Canada. It has also greatly enlarged the total area of factories. The gross output of manufacturing industry increased by at least one-third in 1941 over the gross output of 4529 million dollars recorded for 1940.

TRANSPORT ROUTES OF THE DOMINION OF CANADA

(To be continued)

America's Wartime Merchant Fleet

(By an American Correspondent)

No. VI—*(Continued from page 6, July 2nd)*

Transportation and Fabrication

LOST motion, lost time and inadequate use of transporting facilities are sedulously avoided at the Bethlehem-Fairfield Shipyard, because in the end they entail a money loss. For example, even though the major part of all materials going into "Liberty" ships is obtained through the Maritime Commission, when such orders are for large amounts from a single vendor, the shipyard can make special arrangements with the vendor to load only carload lots in shipping a particular size material. This makes the utmost use of each car and avoids re-sorting, minimises the amount of handling needed, and reduces switching at the shipyard. This practice is especially helpful in the shipping of piping to the yard. Loading and moving materials at the fabricating plant and at the shipyard would be needlessly wasteful but for the routine that has been evolved. To

begin with, about 120 carloads of materials and equipment manufactured elsewhere arrive at the yard daily from outside sources, and over fifty carloads of fabricated material and sub-assemblies are moved each day from the fabricating plant to the shipyard, two miles away. From the storage areas or stockyards at the shipyard, quite thirty-five cars and over 100 lorries, each twenty-four hours, are reloaded from these reserves and carried to the several slipways. Furthermore, twenty-five cars are loaded and unloaded daily in moving piping and machinery to the slipways and to the outfitting piers.

The circulatory system between the fabricating plant and the shipyard, as well as within each of those two sections, is dependent upon the well-planned use of 200 freight cars, 18 locomotives, 53 locomotive cranes, 36 mobile cranes, 38 tower cranes, 37 bridge cranes, 78 lorries with 20 trailers, and some other lesser transporting equipment. The aim is to keep all rolling stock actively employed by loading it promptly at one end of the run and unloading it with despatch at the other end. The number of idle cars is held to a minimum and every car in service is made the most of. Train movements are so timed that each locomotive on delivering loaded cars at a prescribed point finds there or on the return run empty cars to be moved to reloading points or to be pulled to some other of the sections of the diversified undertaking. The avoidance of lost motion is sought in every department of Bethlehem-Fairfield Shipyard, Inc.

Each "Liberty" ship built at the plant represents the putting together of 2890 short tons of steel, and the hulls have riveted seams, riveted frames in fore and after peaks, and riveted deck houses. This work calls for the driving of 114,000 rivets, and the remainder of each hull is bound together with 195,000 linear feet of welding. Of that welding, 95,000ft. is done on assemblies produced either in the fabricating shops or on the ground in front of the ways, while the remaining 100,000ft. of welding on a hull is done while the craft is on a building way. It has been estimated that a "Liberty" ship if riveted throughout would require the driving of about 845,000 rivets, and the drilling or punching of approximately 1,790,000 rivet holes. Therefore welding reduces by 731,000 the number of rivets driven on each "Liberty" ship built in this yard, and correspondingly cuts down the number of rivet holes to be drilled or punched.

To make for easier understanding, the steps by which cargo carriers are constructed, we shall take up first the work at the fabricating plant and from there go to the shipyard and the slipways, so as to trace the sequence by which raw materials become, in an orderly but rapid manner, a large craft ready for launching.

Fabrication

The fabricating plant has four fabricating shops—three of moderate size and one that is said to be the largest shop of its kind on the Atlantic Coast. Together, these shops prepare all steel worked into the ships, and 75 per cent. of that fabricated material is assembled in sections that range up to 10 tons each. The main shop is especially suited for operating on a straight-line production system, which, in broad terms, depends upon raw material flowing in at one end, following, through one of the three bays, a succession of fabrication processes, and, finally, being assembled on tables at the farther end of the shop ready to be loaded on to freight cars of suitable types for hauling to the shipyard. The main fabricating shop has a length of 1680ft. and is divided longitudinally into three bays, each 90ft. wide. This shop permits work to be carried on continuously, day and night, and the workers are unhampered by outside weather conditions. The maximum dimensions of any fabricated section are restricted only by the overhead and breadth clearances fixed for railway clearances by the regulations of the U.S. Interstate Commerce Commission. All steel plates, shapes, and angles reach the fabricating plant by the Baltimore and Ohio Railroad, and are stored in an open stockyard at the supply end of the fabricating shop, the raw material being moved into the shop as required. In that stockyard there are cranes for handling the different materials, and there are a number of burning tables where the steel can be cut to approximate sizes by oxy-acetylene torches. The main fabricating shop discharges the fabricated material on cars which travel upon the Baltimore and Ohio tracks onward to the shipyard.

The plant equipment is diversified and ample enough to meet all needs of the work in hand. At the admission end of this major fabricating shop are plate furnaces, with adjacent bending slabs, and farther along there is an angle furnace with adjoining bending slabs, with contiguous burning floor and platen table. The burning tables are variously used for manually guided or automatically operated gas cutting machines, which are employed to cut straight or curved lines, manholes, &c., or to prepare plate edges for welding. Platen tables are used for assembly work, welding, lay-out operations, and for whatever may be needed in progressively advancing fabrication and assembly. The "Travograph" tables are equipped with two of these gas cutting machines, which are used, for example, for simultaneously cutting one edge of two floor plates, and may be equipped, as desired, either with a manual tracing device head or a magnetic tracing device head guided by a tracing device body. The machine operates on a pantographic principle and may carry one or several cutting torches. These machines are capable of cutting a well-nigh unlimited variety of shapes from steel plates, &c. This fabricating shop has a furnace with a draw capacity heat of from 350 deg. to 250 deg. Fah.; a furnace with an annealing capacity heat of from 1400 deg. to 1850 deg. Fah.; a third furnace with preheat capacity of from 1400 deg. to 1850 deg. Fah.; and a fourth furnace of high heat capacity ranging from 1850 deg. to 2400 deg. Fah. The main shop is amply equipped with travelling cranes, jib cranes, and hoists capable of handling all raw materials, fabricated parts, and assemblies that are produced within the building. This shop also is outfitted with power hammers, punches, shears, drills, a frame bender, &c., to meet the maximum demands of the different services that have to be performed. At one end of the main shop there is a 30ft. hydraulic roll for shaping cold plates. This unit has a capacity of 1500 lb. per square inch and can handle plates up to 1¼in. thick. There is another 30ft. roll that can deal with plates up to ¾in. in thickness. There are three hydraulic presses, one having a range from 450 tons to 900 tons, one of 500 tons, and another of 1000 tons. The three plate and angle furnaces, at 1800 deg. Fah., have each a capacity of from 6000 lb. to 8000 lb. of steel an hour. The welding equipment, both hand and machine, consists of numerous units of several types that have been found thoroughly suitable for the work to be done.

At the beginning of operations, when the initial fifty "Liberty" ships were on order, the welding work utilised all 25-cycle current obtainable at Fairfield Shipyard, and at that time no 60-cycle current was to be had. At the start of work at the yard it was believed that hand welding would meet all requirements during the construction of the fifty ships, and the 25-cycle current sufficed when amplified by energy supplied by a number of gas-driven generators. A few months later, however, Bethlehem-Fairfield Shipyard got a second contract—one for twelve additional "Liberty" ships, and then was felt a pinch in the power supply. The situation was mastered for the time being by purchasing 600 portable welding machines and by installing several 60-cycle generators. That was the start of the use by this company of welding machines. Both hand welding and machine welding have their distinctive applications and merits.

Adjacent to the west side of the main fabricating shop there is a building that houses a pattern shop, a machine shop, and a mould loft. The machine shop is well equipped with machine tools to meet the purposes of maintenance and repair and for performing other services in connection with the fabricating plant. The mould loft is used in connection with the many templates employed in laying out plates of different shapes for cutting. One of the busiest shops in the fabricating plant is the pipe shop, where are fashioned some of the structural conduits that form the arterial system installed in each "Liberty" ship as the craft is put together on the ways. In this shop all piping that goes in the double bottom is placed in position in sub-assembled sections while those sections are in process of construction on the platen table. Because of this, the inner bottom piping on a ship can be completed in one or two days after the tank top sections have been erected in a hull. A copper shop, within the pipe department, is a separate unit, although under the same superintendent. The steam required for heating and power purposes in the fabricating plant is furnished by three horizontal return-tube boilers, each of 250 H.P., that have a working pressure of 150 lb. per square inch. The boilers are oil fired.

Pipe Work

The principal pipe shop, situated in the shipyard, is completely up to date in its mechanical equipment and fully capable of fabricating and preparing all pipe sub-assemblies needed for the vessels building at the shipyard. The shop contains six pipe machines, tooled for cutting, threading, grooving, reaming, and bevelling pipe ranging from 1¼in. to 8in. in diameter, and there are four pipe machines that are tooled to deal with pipe from ¼in. to 2in. in diameter. There are two hydraulic benders, one geared for piping from 1¼in. to 4in. in diameter, while the larger bender is capable of handling pipe from 4in. to 8in. in diameter. Each bender is equipped with two complete sets of dies, one set based on a radius of three times the inside diameter and the other one on a radius of six times the diameter. There are six hydraulic benders that are manually operated and geared for pipe ranging from 2½in. in diameter downward. These benders operate continuously, and a number of spares are held in reserve and in good repair to meet any breakdown. The shop is also provided with drill presses, a lathe, and power saws for pipe cutting. There are, besides, grinders and miscellaneous smaller power-driven tools for various services. The pipe shop works on a production schedule that is based on the fabrication requirements of ten ships at a time. For example, the shop is geared for

8in. work until the requirements for 8in. pipe for ten ships are taken care of, and this is followed by a similar output of 6in. pipe, 5in. pipe, and on down to 1¼in. pipe, successively. It is said that this has been found to obviate lost time and motion which would occur owing to frequent changes of cutting tools, bending dies, &c.

Most of the piping placed in a "Liberty" ship has to undergo one or more processing operations, and substantially all difficult welds are completed in the pipe shop, from which it is sent to the ways ready to be bolted up. Furthermore, the lines handling fuel oil transfer and oily ballast, clean ballast, and certain steam mains are prefabricated in their entirety, including welding, before they are sent to a ship to be secured in place.

Fire lines, steam supply, and exhaust lines for deck auxiliaries, deck drains, and plumbing are cut in the shop to prescribed standard measurements, threaded, and fitted with screw flanges on both bends and straight lengths to facilitate quick bolting up when in place on a ship. The more difficult pieces of piping are prepared with jigs, made in the shop, so as to obtain uniformity and easy fitting when installed on shipboard. Replicas of engine-room bulkheads are set up in the pipe shop, with holes properly placed and manifolds, &c., located, in accordance with the ship drawings. This makes it possible to fit and bolt in place and tack-weld the piping for the fuel oil and oily ballast and the clean ballast system of an entire engine-room. The piping, after this preliminary preparation, is taken down and welded on the shop floor. Each piece of piping is marked with its identification number and placed in storage until required for installing on the ships agreeably to a prearranged schedule. The fabricated piping is arranged in orderly piles on an assigned storage space and in numbered rotation. The groupings of associate fittings, valves, and the like are adjacent to their respective leaders, and when this material is needed for a ship it can be quickly loaded on a truck and speeded to the ways, where a crane can pick up the material and place it where desired on the ship. Confusion and wasted time are thus avoided, and because an accurate check is kept of the materials delivered to the different hulls under construction, there is but very little unused material left at a slipway for return to storage. The advantages of this system of control will be readily appreciated by anyone familiar with the workings in the average yard.

As far as practicable, all piping reaching the pipe shops arrives in carload lots, each carload of a given size. The cars are unloaded at pipe racks designed for holding their respective sizes and lengths of piping, and the larger and heavier piping is placed in the racks nearest the shop door, and as the piping diminishes in diameter it is stored in racks farther from the shop entrance. Black pipe is arranged in one row, galvanised in another, and seamless pipes in still another. As needed, the required piping, in the desired quantity, is placed on hand cars constructed particularly for that service and drawn by a small petrol tractor to the pipe shop entrance and there picked up by electrically operated overhead lifts or by a monorail system for conveyance to its assigned destination, where it is placed in smaller portable racks that are conveniently located near a machine or operating point. As has been mentioned in a description of Bethlehem-Fairfield Shipyard, the diversified force of pipe fitters, coppersmiths, welders, burners, handymen, and helpers are looked upon as specialists, and each man has been qualified for his particular task by special training.

PLANT MAINTENANCE

The plant engineering department is responsible for all plant construction work and the facilities that assist in the shipbuilding activities. In the first place, it supervised the reclamation work that transformed the low-lying and widely boglike area of a tidewater shore into a great shipyard of a unique character. To-day the shipyard has sixteen slipways instead of the originally projected thirteen ways, and all buildings standing on the shipyard property at time of leasing have been enlarged two or threefold, whilst other structures have been newly erected to meet the requirements of the various directive and operating departments. There is a cafeteria and a well-appointed hospital, an air compressor plant of large capacity, and two electric sub-stations, one for 25-cycle current and the other for 60-cycle current. All electric cables are carried in conduits that radiate from the power-house to the sixteen slipways and to the various buildings. The compressed air lines and the fresh-water and salt-water mains are laid in utility trenches, and there are connections with each slipway and to other places in the yard. There is also in the yard a sizable and well-equipped machine shop that has much to do in the building and outfitting of each "Liberty" ship.

SHIP ENGINEERING

The technical divisions of the ship engineering department of Bethlehem-Fairfield Shipyard are hull division, machinery division, electrical division, and test division. The hull division is responsible for the main structure of each ship, the living accommodations, sanitary and ventilating arrangements, navigating and safety equipment, deck machinery, and cargo handling gear. Also under this division are carried out the launching calculations and operations. The machinery division has to do with the main propelling machinery, the boilers, the piping, and the auxiliary equipment identified with that department of the craft. The electrical division's work covers the lighting, the communication, the radio, and the degaussing systems of the ship. The test division of engineering carries out dock trials and arranges and conducts the acceptance trials, and upon it also rests the lesser duties of arranging for the ship's official number, her registry in a home port, and for the Master Carpenter Certificate, which has to be filed with the Collector of Customs, besides obtaining certificates from the American Bureau of Shipping, the Bureau of Marine Inspection and Navigation, and the United States Public Health Service. Following the completion of a vessel, the plans used for guidance during her building are rechecked, all changes and revisions noted, and those drawings are filed away in a fireproof vault for future reference, if desired.

(To be continued)

TIMBER FOR PIPES.—On many new war plants in the U.S.A. sewage and other pipes made of timber are being used. Similar pipes have been successfully employed in the past. One Californian concern has recently removed a creosoted culvert that had carried acid fruit wastes for seventeen years, but was still in good condition. The sewer was built in 1925 of 2in. by 12in. lumber in lengths of 12ft. to 20ft. The timber was pressure treated with an average retention of about 8 lb. of creosote per cubic foot of wood. Prior to 1925 the waste was discharged through concrete pipes of 10in. or 12in. diameter. The usual service life of such pipes was three or four years.

A Distilling Apparatus for Ships' Lifeboats*

By G. KEENAN

DURING the present war years much attention has been directed towards improving the life-saving equipment carried in ships' lifeboats. These improvements have done much to save life and minimise suffering after vessels have been sunk by enemy action.

There is one problem, however, that remains to be solved, and that is the provision of a sufficient supply of drinking water. The law requires that each boat shall carry 112 oz. of fresh water for every person the boat is certified to carry, and much ingenuity has been exercised in order to comply with this requirement.

This allowance is ample provided the survivors are rescued within a reasonable time—say, fourteen days. It sometimes happens, however, that this supply has been seriously diminished by leakage and other causes, such as concussion, shell splinters, &c. Regular inspection of the boats should reduce this first-mentioned risk considerably.

Many ships' lifeboats have been forced to spend long periods at sea before rescue was effected. In these cases great hardship has been inflicted on the survivors through having to exist on a meagre supply of water or, just prior to rescue, no water at all. It is therefore clearly desirable to find some means of augmenting the supply of drinking water or, in extreme cases, provide an alternative means of supply.

Much experimental work has been done to achieve this aim, but straightforward distillation of sea water offers, at present, the only reasonable solution.

The distillation of sea water for the purpose of providing potable water for domestic use has been carried out on board ships since the early days of steam, but it had not been thought possible to make a plant small enough and, at the same time, with a large enough capacity to make its use worth while in a lifeboat. The question also arises as to what kind of fuel the apparatus should burn.

Liquid fuels such as petrol, paraffin, and light diesel oil have great advantages from the point of view of high calorific value, but, being liquids, have to be stored in suitable containers. These containers are also liable to the same defects as water tanks; furthermore, the apparatus must be fitted with some form of burner. Such burners would have to be of robust, reliable, and efficient construction and impervious to the action of salt atmosphere. To get a high degree of efficiency the burner would probably have to be of the surface combustion type, working on the well-known Spencer-Bonecourt principle in order that the maximum amount of sea water may be evaporated per pound of fuel. There would be the added complication of pipe connections between the fuel tanks and the burners. It would not be desirable to transfer from the main storage tank small quantities of inflammable liquid to the apparatus from time to time. Therefore some means of transferring the fuel to the burner direct is essential. A properly designed apparatus burning paraffin or petrol should give a gallon and a half of distilled water per pint of fuel used. Limitations imposed on this apparatus are those of the amount of available fuel stored and effectively burned.

The ideal characteristics of a distiller for this purpose should be that it is safe, compact, efficient, easy of operation, and requires no special lay-out when fitted to the boat. It should operate without priming under the worst conditions in which it is likely to be used. It should also be capable of burning any combustible matter.

The following is a description of an apparatus which has been developed and marketed under the name of "Minimax K M Fresh-water Producer."

This apparatus is primarily designed to burn wood as fuel, this being the combustible matter most likely to be available in any quantity after a ship has been sunk. It will also burn com-

* Reprinted from the "Transactions" of the Institute of Marine Engineers.

bustible liquids of any kind, and other combustibles such as kapok, cloth, rope, and in fact any material that will burn.

Figs. 1 and 2 show the details of the apparatus, which consists of a small conical furnace surrounded by a cylindrical water jacket. The apparatus is provided with a detachable cover, which is jointed on the outer circumference to a flange on the water jacket, and secured by means of wing nuts on hinged bolts. The cover is annular in shape and is supported by a screwed ring with a collar, brazed on to the furnace. A steam-tight joint is made by means of a ring nut and grommet, the cover being sandwiched between the collar and the ring nut. The underside of the cover is provided with a conical baffle plate. The outside of the water jacket is well lagged and the lagging is secured by means of a strong sheet metal cleading. The cover is also well lagged and cleaded. At one side of the water jacket a small vertical single-tube type of condenser is fitted and this is connected to the boiler by means of a U bend. In the later models the U bend is permanently fitted to the top cover and provides a ready means of lifting it. The U bend is connected to the condenser by means of a screwed connection.

The condenser is merely an internal tube fitted with an outer water jacket. The upper portion of this jacket is provided with a branch connection which fits the base of the standard manual bilge pump, now required by law to be carried in a lifeboat. On the lower portion of the jacket is fitted a three-way cock, one branch of which is connected to the boiler, whilst another forms a connection on to which a length of flexible hose is fitted for the purpose of discharging the circulating water. Baffles are fitted inside the water space of the condenser in order to cause the cooling water effectively to sweep over the surface of the condensing tube. A handle is fitted to the three-way cock and the travel of this handle is limited by two fixed stops. When the handle is against one stop the water is allowed to flow into the boiler, and when against the other stop the boiler is shut off and the water allowed to flow away to discharge. These stops are suitably marked to indicate their purpose. Thus it can be seen that the three-way cock forms a convenient means of filling the boiler without the possibility of accident.

On the opposite side of the boiler to the condenser is fitted a gauge glass. This gauge glass is protected by a strong perforated hinged metal guard, secured by strong clips.

The apparatus is mounted on a suitable baseplate, separated from the bottom of the boiler by distance pieces, thus forming an air space. The bottom plate forming the boiler foundation is perforated with a number of small air holes; these, together with a number of similar holes drilled in the base ring of the boiler, provide the necessary air for combustion. As previously mentioned, heat losses are reduced to a minimum by lagging in a suitable manner all the external parts of the apparatus. The baseplate has a hole drilled in each corner, by which it may either be secured to the boat by being lashed down to a thwart, or may be nailed or screwed to any part of the boat suitable to the purpose. A metal chimney is provided and fits over the top ring nut. The chimney is cut off at an angle of 45 deg. at the top, and the draught may be regulated by turning it with reference to the wind.

The distiller is merely lashed, nailed, or screwed down in a convenient position near the manual pump. The end of the section hose of this pump is placed over the gunwale of the boat and immersed in the sea (it should be long enough for the purpose). The delivery hose is forced on to the connection provided for the purpose on the distiller condenser, and the end of the small hose attached to the three-way tap on the distiller is placed over the gunwale. The attachments on the cover are now tightened up by hand and the apparatus is ready for use.

The handle of the three-way tap is manipulated so that the water jacket of the condenser is placed in communication with the condenser. A few strokes of the manual pump fills the boiler to the level of the upper gauge glass connection. The three-way tap is then turned so as to discharge the circulating water from the manual pump overboard.

A piece of cloth, waste, or kapok is dipped in oil (sperm oil is carried in the boat) and lighted. It is then dropped into the fire-box of the apparatus from the top. When alight, chips of wood are fed in and when well alight the condition of the wood regarding dryness does not matter. Ten minutes after lighting, vapour will issue from the condenser, and circulation should be commenced by gently working the manual pump. A small length of surgical hose attached to a connection fitting the condenser is provided for the purpose of conveying the condensate to a suitable receiver.

The boiler is fed with wood at periodic intervals, and when the water level reaches the lower level of the gauge glass the boiler is refilled. Evaporation and refilling is repeated five times, and after letting the fire die out the apparatus is cleared by removing the cover and wiping out the interior. Cleaning is thus carried out before the contents of the boiler have reached the "brining" point (35 oz. to the gallon); thus no salt is deposited, and as the apparatus is worked only at atmospheric

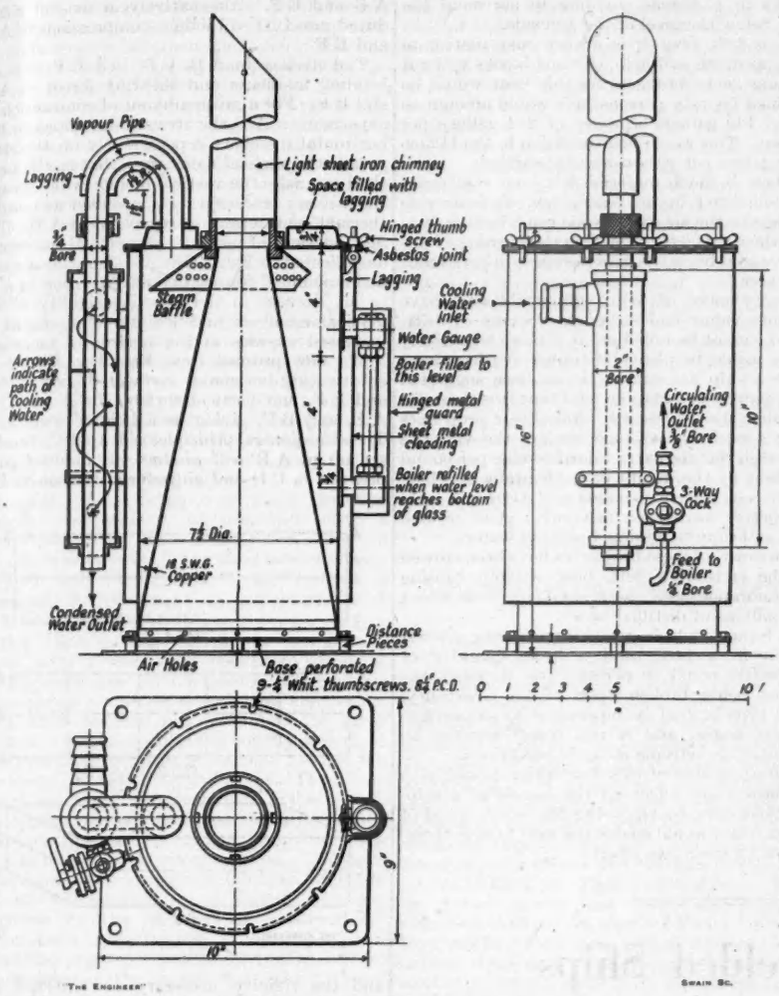


FIG. 1—*Distilling Apparatus for use in Ships' Lifeboats*

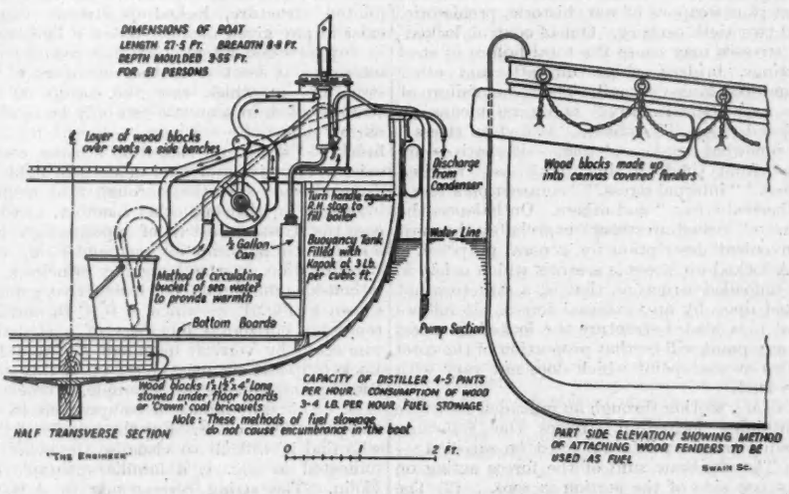

DIMENSIONS OF BOAT
LENGTH 27-5 FT. BREADTH 8-6 FT.
DEPTH MOULDED 3-55 FT.
FOR 51 PERSONS
Layer of wood blocks over seats & side benches
Turn handle against R.H. stop to fill boiler
Discharge from Condenser
Wood blocks made up into canvas covered fenders
½ Gallon Can
Buoyancy Tank Filled with Kapok at 3 Lb. per cubic ft.
Water Line
Method of circulating bucket of sea water to provide warmth
Bottom Boards
Pump Section
Wood blocks 1"x1½"x4" Long stowed under floor boards or "Crown" coal briquets
CAPACITY OF DISTILLER 4-5 PINTS PER HOUR. CONSUMPTION OF WOOD 3-4 LB. PER HOUR. FUEL STOWAGE
Note: These methods of fuel stowage do not cause encumbrance in the boat
HALF TRANSVERSE SECTION
0 1 2 FT.
PART SIDE ELEVATION SHOWING METHOD OF ATTACHING WOOD FENDERS TO BE USED AS FUEL
"THE ENGINEER"
SWAIN SC.

FIG. 2—*General Arrangement of Distiller Fitted in a Ministry of War Transport Standard Ship's Lifeboat*

pressure any salt formed is soft and easily removed.

About 3 gallons of water can be distilled between each cleaning.

The consumption of wood is about 3 lb. per hour without the chimney, and the evaporation at least 4 pints per hour. Under favourable conditions the apparatus has produced 5 pints in the hour, the chimney being used to induce more draught. The consumption of wood in this instance was 3½ lb. per hour.

Besides providing drinking water, the apparatus has many other uses.

If a quantity of hot water is desired, it is only necessary to stop circulating the condenser and to immerse the end of the condensate hose in the water to be heated. In a few minutes the water will be warmed up and may be made into a hot drink by dissolving the ration chocolate tablets or milk tablets.

In extremely cold weather a small quantity of sea water may be pumped into the bottom of the boat. The free end of the suction hose of the manual pump should be placed in the water and the discharge from the condenser allowed to discharge inboard. In this manner the water in the bottom of the boat may be circulated through the condenser and soon the water in the bottom of the boat will be heated, thus providing warmth for the occupants of the boat. If a bucketful of sea water is circulated in the same manner the contents will reach 150 deg Fah. in about twenty minutes. If this hot water is poured into suitable bottles, warmth could be provided for injured persons or persons suffering from shock. This heat is not obtained at the expense of the production of fresh water.

Smoke-producing tablets made of tar residue, with saltpetre and sulphur, about 1in. in diameter and ¼in. thick dropped into the fire-box, will produce a dense column of smoke for a considerable period. As a night signal, tablets of saltpetre with a trace of strontium chloride will produce a prolonged crimson flare, which is not easily confused with the flashes from artillery.

These tablets need not be larger than medicinal tablets in daily use, and should be cheaply produced. Owing to their small bulk large numbers could be carried, and it is immaterial whether they are kept dry or otherwise.

There are many ways wood fuel could be stored in a boat without causing encumbrance. A layer of wood blocks cut from good wood scrap could be nailed over the seats and side benches, the spaces between the oar cases and the underside of the side benches packed with it, and also the useless spaces in the bow and stern of the boat.

Another method is to make a belting of wood blocks in a canvas covering to surround the boat below the level of the gunwale.

In a 28ft. boat it is a very easy matter to store as much as 700 lb. of wood blocks without causing encumbrance. As this boat would be certified for fifty persons, this would amount to about 120 gallons of water or 2·4 gallons per person. This would be in addition to the 112 oz. or ¾ gallon per person already carried.

There is much material in a boat that could be consumed in an emergency, such as side casings to the air cases, wood gear, lockers, &c., and the only factor regarding the burning of this gear would be, is the gear desirable in preference to water?

Every piece of driftwood would now have definite value, and although recovery of driftwood cannot be relied on, it is more than likely there would be plenty of timber floating about after a ship has sunk. It has been suggested that patent fuel may be used, but it is doubtful whether these fuels will retain their properties over a period of storage, and in the varieties stored in tins the extra calorific value per pound is offset by the weight of the containers, which have no calorific value. "Crown" coal briquettes have been used with good results, 1 lb. of briquette giving 4 pints of water.

Two cwt. of these briquettes have been stowed in the ends of a 26ft. boat without causing encumbrance, and these would provide about 120 gallons of distilled water.

A locker could be made by enclosing a lower bench in a boat, and a large quantity of briquettes could be permanently enclosed, the locker being broken open in an emergency. This type of fuel is impervious to submersion in sea water, and is not much affected by exposure to extreme climatic conditions.

An apparatus of this description would have a considerable effect on the *morale* of a shipwrecked crew by removing the worst dread of seamen and would enable the men to save themselves by their own efforts.

Fractures in Welded Ships

By JOHN TUTIN, D.Sc., M. Inst. N.A.

A LOCKED-UP stress may be controlled, like friction, in such a way as to be the servant of the engineer. Uncontrolled, it is likely to be his enemy. For example, locked-up stresses are consciously or subconsciously employed, under control, in many familiar devices, such as a nut and bolt, a rivet, a loaded spring, a shrink fit, a braced wireless mast, and numerous weapons of war, historic, prehistoric, and twentieth century. Out of control, locked-up stresses may cause the total failure of steel castings, bridges, ships, aircraft, and other structures, large or small. The recent failure of the s.s. "Schenectady" is by no means an isolated case. The phrase "locked-up stress" is somewhat crude and many alternatives are used from time to time, such as "residual stress," "internal stress," "contraction stress," "thermal stress," and others. On balance, the phrase "locked-up stress" is probably the most convenient description for general purposes.

A locked-up stress is a stress which exists in an unloaded structure, that is, a structure not acted upon by any external forces. It follows that in a loaded structure the locked-up stress at any point will be that proportion of the total stress at that point which does not vary with the load.

At any section through an unloaded structure containing locked-up stresses the following conditions of equilibrium must be satisfied:—(1) The algebraic sum of the forces acting on any one side of the section is zero. (2) The moment of resistance of the section is zero.

Further rules can now be written down as follows:—(3) It is impossible to have a structure containing a single locked-up stress. (4) It is impossible to have a structure containing only two locked-up stresses. The minimum conditions for equilibrium are either three locked-up stresses or two locked-up stresses in association with one locked-up moment. (5) In a pin-jointed structure, locked-up stresses cannot exist in any given member unless a line drawn in any direction intersecting that member also intersects at least two other members of the structure, in which case the nature of the stresses taken in sequence can only be of alternating signs: (+ − +) or (− + −). (6) In a bracketed structure, locked-up stresses cannot exist in any given member unless a straight line drawn in any direction through that member intersects at least one other member, in which case the stresses must be of opposite sign, with a moment or moments intervening (+, M, −).

In relation to the foregoing principles, let us consider the simple, but instructive, example shown in Fig. 1, in which A B, C D, and E F represent horizontal members of a structure, connected by vertical members A E and B F. Locked-up stresses may be set up in this structure by introducing, for example, a tension in A B. This will induce a compression in C D and a tension in E F. For the benefit of those who find it difficult to visualise the conditions indicated in Fig. 1, a familiar example is a violin. The string corresponds to A B, the body of the case to C D, and the back of the case to E F. Tightening the strings (tension) produces a tendency to crush the body (compression) and rupture the back (tension). If the structure is symmetrical and the force in A B is P, the force in E F is also P, and in C D it is 2 P. If in such a case the cross sections A B, C D, and E F are equal, the compressive stress in C D will be double the tensile stress in A B and E F. Alternatively, a tension introduced into C D will induce compressions in A B and E F.

The stresses in A B, C D, and E F produce bending moments and shearing forces in A E and B F. For a given amount of contraction or expansion in A B the stresses developed in the horizontal members depend solely on the stiffness of the vertical members; that is, the more rigid we make the vertical members the greater the stresses produced by a specified amount of thermal contraction or expansion in A B. The introduction of additional vertical members, as indicated in Fig. 2, is equivalent, for a specified amount of contraction or expansion in A B, to an increase in the effective rigidity of the vertical members and will therefore result in increased stresses in the horizontal members.

We now proceed from Fig. 2 to Fig. 3 by substituting horizontal surfaces in lieu of A B and E F, and vertical surfaces in lieu of C D, A E, and B F, giving us a hollow closed box. The same general principles still apply. Tension set up in A B will produce an induced compression in C D and an induced tension in E F

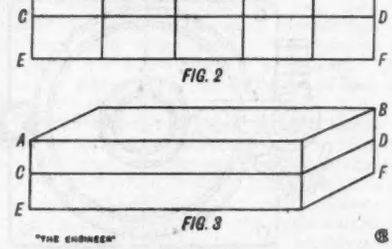


FIG. 1

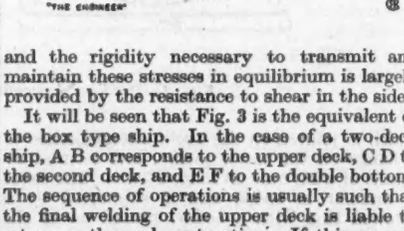


FIG. 2

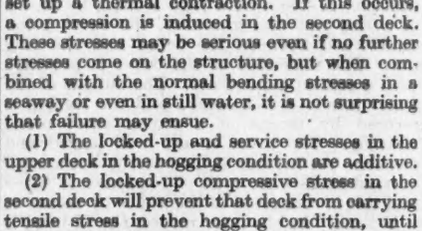


FIG. 3

and the rigidity necessary to transmit and maintain these stresses in equilibrium is largely provided by the resistance to shear in the sides.

It will be seen that Fig. 3 is the equivalent of the box type ship. In the case of a two-deck ship, A B corresponds to the upper deck, C D to the second deck, and E F to the double bottom. The sequence of operations is usually such that the final welding of the upper deck is liable to set up a thermal contraction. If this occurs, a compression is induced in the second deck. These stresses may be serious even if no further stresses come on the structure, but when combined with the normal bending stresses in a seaway or even in still water, it is not surprising that failure may ensue.

(1) The locked-up and service stresses in the upper deck in the hogging condition are additive.

(2) The locked-up compressive stress in the second deck will prevent that deck from carrying tensile stress in the hogging condition, until sufficient bending has taken place to bring the plating into tension.

(3) The effect of this induced compression in the second deck will be to increase the tensile stress which the upper deck must carry. In fact, until the compression in the second deck has been reduced to zero the vessel must be regarded as a single-deck ship from the point of view of its resistance to longitudinal bending.

(4) The induced compression in the second deck will tend to produce buckling, and if buckling occurs it is likely to coincide in longitudinal position with the incidence of locked-up tension in the deck above. This is confirmed by the observed facts. Incidentally, the marked tendency of the ends of a welded ship to lift during construction is of special interest as

indicating the magnitude and nature of the forces at work.

(5) Stress transmission between the upper deck and the side shell will augment the load carried by the sheer-strake, stringer connection, the welding of which calls for special consideration in relation to peak loads in the hogging condition.

(6) The reaction tension in the double bottom (keel, bilge, and tank top) will, in a normal case, be considerably less than the action tension in the upper deck (equating moments about the second deck). Therefore the double bottom may be expected to function with reasonable efficiency in both the hogging and the sagging condition.

(7) The upper deck, in the sagging condition, cannot develop a compression stress until the tension therein has been reduced to zero.

(8) The neutral axis in a seaway will be in a state of vertical oscillation relatively to the keel, the amplitude of oscillation being largely governed by the magnitude of the action and reaction stresses.

(9) The hull deflection for moderate conditions of loading will, if locked-up stresses are present, be greater than anticipated, due to the reduction in effective moment of resistance. On the other hand, the deflection associated with incipient local fracture will be much less than anticipated owing to the reduction in the margin of safety. This, in a sense, is equivalent to a "reduction in flexibility."

(10) At the change-over point between hogging and sagging, in association with a sudden movement of the neutral axis, there will be a sudden increase in the time rate of change of hull deflection. This "snap" effect is important in relation to the impact values of the plating and weld metal.

The "Schenectady" broke in two in still water with a calculated maximum stress of 4½ tons per square inch, indicating the presence of locked-up stresses of considerable magnitude, even after making full allowance for other factors. Less spectacular but equally important fractures have occurred from time to time, on the stocks, in still water, and at sea. The official report on the "Schenectady" states:—"In the opinion of the Committee the failure of the hull structure of the 'Schenectady' was due to a combination of circumstances. The principal cause was an accumulation of an abnormal amount of internal stress locked into the structure by the processes of construction." Calculations made for the "Liberty" type of all-welded ship show that the effect of an induced compression in the second deck may by itself cause an increase in the nominal service stress on the upper deck of the order of 30 per cent., apart altogether from the numerical values of locked-up stresses and stress raisers. Incidentally, an inspection of a major fracture on one of these vessels revealed that the fracture, which started in the upper deck under tension, entered the second deck in way of a pronounced transverse buckle, the crack running significantly up the trough of the buckle.

Nevertheless, electric welding of ships has come to stay. Apart from its overwhelming importance to-day as a means of obtaining a vast output of new tonnage, it will inevitably play an increasingly important part in the future of shipbuilding. It is a more agreeable occupation than riveting and it offers a substantial reduction in steel weight compared with riveting. This reduction can only be fully achieved by removing any element of uncertainty and this calls for (1) methods of preventing major locked-up stresses in welded ships under construction, (2) methods of removing major locked-up stresses in existing welded ships. The phrase "major locked-up stresses" is used deliberately, because locked-up stresses are not unknown in riveted ships, and are equally undesirable, but as a rule are better understood and more easily remedied.

In new ships the prevention of locked-up stresses should primarily be the responsibility of the structural designer, and only in a secondary capacity should it be the concern of the "outside" personnel. Correct design should make it immaterial whether or not a given welding procedure or type of welding machine may tend to cause locked-up stresses. There are obvious ways of ensuring this without impairing in any way the efficiency of the structure against service loads or impeding production. For example, a locked-up stress in a welded deck can be prevented by introducing a transverse line or lines of rivets. Similarly, in the shell, tank top, or double bottom. If there is any doubt, a complete transverse belt of riveting can be arranged right across the ship at a convenient station. Since in most cases the action stress resides in the upper deck, it might prove a sufficient precaution to confine this band of riveting to the upper half of the structure. It would obviously be wrong to regard such an arrangement as an "expansion joint." It is essentially a means of stress relieving and the effect is therefore equivalent to large-scale annealing. The effect of a completely riveted sheer strake-stringer connection would be very similar and should be adequate if confined to the amidship half length. Any such riveting should always be completed last. At least one important Continental shipyard employs the riveted belt amidships on all welded vessels, including warships, this particular shipyard having adopted this standard construction as a result of practical experience with welded ships over a number of years.

Although the basic principles dealt with in this memorandum are essentially simple and, indeed, elementary, they have not so far been set down, and there is, of course, a wide field of detailed technical application, not only to ships, but to welded structures of all types.

American Engineering News

Long Pipe Line for Oil

On the 1250-mile pipe line for pumping oil from a Texas oilfield to the City of New York, described in our issue of June 25th last, the first section of 530 miles was completed in January, at the rate of 6 miles daily. This section extends from Longview, in Texas, to Norris City, in Illinois, at which latter place the oil is now delivered to railway tank wagons pending the completion of the line to New York, which was expected in June. The pipe, 24in. in diameter, will deliver 300,000 barrels daily, or the equivalent of 12,600,000 gallons. With its storage tanks and twenty-six pumping stations it will cost in all £24,000,000. On the first section there are eleven stations, each having three centrifugal pumps connected to electric motors of 1500 H.P., to operate under a pressure of 750 lb. per square inch. At Norris City there are fifteen storage tanks, each of 80,000 barrels capacity, with extensive railway tracks and facilities for loading 1000 tank wagons daily. Land was cleared to a width of 50ft., and a ditching machine cut a trench 3½ft. wide and 3½ft. deep. Pipe was distributed along the line in lengths of 38ft. to 44ft. by motor lorries, and was unloaded by crawler tractors having side booms or jibs to serve as cranes. While supported over the trench the lengths were first tack welded and then full welded at the butt joints. The pipe was then cleaned by revolving wire brushes, coated with tar enamel, and spirally wrapped with asbestos felt by means of special machines, thus providing against corrosion and deterioration of value. The pipe was then lowered into the trench and covered with at least 2ft. of backfilling. Four or five lengths of pipe were welded to form sections of 160ft. to 200ft., which were laid and covered in one operation. For changes in line and gradient the pipe was bent in the field by block and tackle, the pipe being heated by blow torches, if necessary. For crossing rivers, the pipe is weighted by cast iron split sleeves and laid in a dredged trench.

Disposal of Sewage Sludge

A study of methods of treating and disposing of the sludge from sewage treatment plants at some American cities shows a variety of methods and experiences. At Buffalo, where the sludge is the product of primary sedimentation, the treatment includes partial digestion, vacuum filtration, and incineration. The sludge is conditioned for filtration with lime and ferric chloride. The filter cake is passed through driers, and the dried and powdered sludge is blown into the furnace, where it burns in suspension. A major difficulty has been in severe abrasion of the driers, fans, and cyclones. At bends in pipe lines and ducts this trouble has been reduced by the use of concrete, which is easily renewed when worn. In other cases, primary dewatering of digested sludge by vacuum filters is employed, and the elutriation or washing of the sludge has effected material economy in operating costs. But experience at St. Paul indicates that too much of the cost of sludge disposal is devoted to the filtration and other processes which simply prepare the sludge for incineration. Economy lies in the simplification of these preliminary processes, and with moisture content of sludge reduced, the dewatering on vacuum filters could be dispensed with, assuming that the incinerators could handle this sludge. In fact, some plants are incinerating liquid sludge. Arguments are being made for more general use of sewage sludge as a fertiliser and soil conditioner, rather than to waste it, especially in view of the dearth of farm manure. At Chicago, with sewage and industrial wastes equivalent to a total population of seven million, the waste activated sludge is dewatered, dried, and processed either for incineration or for use as fertiliser. With such a large plant, generation of power in combination with the drying and incineration is found economical. Where drying alone is practised, any excess heat is wasted. The plant has a capacity for handling 375 tons of dry sewage solids daily.

Mississippi River Bridge

Among the many bridges over the Mississippi River, one of the earliest was built at Dubuque in 1887, but traffic conditions and loads had long outmoded it, and a new structure of interesting design is now nearing completion. The bridge proper is a continuous truss, 1540ft. long, including a central arch span of 845ft. and two through truss end spans of 347ft. The approaches, aggregating 5760ft., consist of steel plate girder deck spans of 45ft. to 187ft. A two-lane 24ft. roadway has two sidewalks, 5ft. and 2ft. wide, the latter for safety or emergency use. The arch has a rise of 102ft., and attached to it are hangers which carry the longitudinal tie members and transverse floor beams. The shore ends of the two flanking spans are supported on rocker posts, 8ft. high, on the piers to provide for expansion movements. Expansion bearings are provided also on the two river piers carrying the arch. These bearings are seated on 12in. steel rollers, about 6ft. long. An unusual feature is a vertical pintle pin on one of the river piers; it is 12in. in diameter, 41½ft. long, deeply embedded in the pier, and having its upper end engaged in steel framing on the end floor beam of the arch. Its purpose is to take all longitudinal loads due to traffic and wind for the entire continuous length of 1540ft. It eliminates torque in the pier due to transverse wind pressure. With the two side spans erected their shore ends were attached to hydraulic 250-ton jacks to permit of adjusting the level of the bottom chords as the 845ft. arch was cantilevered out from the river piers. From one pier, however, both the arch and the shore span were cantilevered in opposite directions, maintaining the necessary anchorage weight. The arch was closed at the crown by a device having four 350-ton hydraulic jacks by which the ends of the bottom chords were pulled together.

CONCRETE-COATED PILES.—The United States Engineer Department has recently carried out a new technique in pier construction of a temporary character. The shortage of steel precluded the use of piles of that metal. Untreated timber was ruled out for the usual reasons; plant for creosoting was not available. The best prospect, it was decided, would be in untreated wood piles protected with a coating of sand and cement shot on with pneumatic equipment to embed wire mesh reinforcing. *Engineering and Contract Record* records that the resultant structure is stated to have such strength, rigidity, and durability that more widespread use of the protective method has now begun to develop.

The Engineer

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THE BATTLE OF GERMANY

IT is nearly three years since the Battle of Britain was fought. The enemy plan had been to begin by air warfare and when full air superiority was obtained to move on to complete invasion with tanks and troops. But, thanks to the high daring and courage of our small but well-disciplined Air Force, we won in the very first round, and any desire on the enemy's part to continue the fight entirely evaporated. The battle to-day is the Battle of Germany, and it has begun in earnest; like the Battle of Britain, it opens with the air phase. In the earlier battle Germany had the immense advantage of attacking a small highly condensed target, of having exceedingly short distances to go, and in possessing substantial superiority in numbers. We have the harder task, a large and diffuse target to attack and vastly greater distances to go. Nevertheless, the battle has opened well. For some time the monthly losses of aircraft by the enemy must be greater than his monthly output, whilst that of the United Nations grows substantially. That is a very slippery slope for the enemy; if it continues it can have but one end. That end will be our dominance in the air.

We have the better equipment, not least in the many things that radio stands for in these days, for, thanks to the foresight of our technicians, we had several years' start, and although some of our apparatus has been captured and copied by the enemy, we have still a convenient margin of superiority in quality; furthermore, although it is of the essence of the radio aids in bombing attack that the technique employed shall be instantly ready to be modified to suit sudden developments, our preparations with that end in view have been and are being vigorously maintained. All that could save the enemy now would be so sudden a technical advance in aircraft fighting ability as to get at least momentarily ahead of us and that we see no reason whatever to anticipate. The enemy has, it is true, lately claimed to possess some new secret technique, but that kind of propaganda he has put out before with the object of encouraging his home front, now so disturbed by the U-boat losses and by our air bombing.

The result of future air combat must depend in no small degree on the ever-growing technical contest between gun and armour. Our 20 mm. cannon gives an immense armour penetrating force compared with the machine gun, and it is fully capable of dealing with any thicker armour with which enemy aircraft may come to be fitted. Increase in armour thickness cannot easily be provided in existing designs, whilst even in new ones there is always the difficulty that extra weight at once lowers flying capacity, especially at the heights at which combat must nowadays be faced; a high ceiling is one of the greatest technical merits a fighter can have. As we have previously pointed out, the extensive use in American aircraft of a gun calibre between the older 0·303in. and the newer 20 mm. size presents especially interesting features. Their calibre of 0·50in., or 12·5 mm., comes in between these two sizes, and its appearance seems to have hit off the very moment in the fight in which any improvement in the armour in enemy aircraft was still incomplete. Thanks to that, and by no means least, to skilful gunnery and good formation keeping, the American "Fortresses," and the other large aircraft carrying this gun, have achieved a magnificent record of enemy aircraft shot down, so much so that for many months they have undertaken very successful raids by day on distant enemy targets even when unescorted and have achieved as great a success against air targets as they have against ground ones. It may be asked how long a "run" this gun can be expected to have. That must depend upon the speed of adoption by the enemy of heavier armour calculated to protect the vital points of his aircraft; but there is another factor. Owing to the limit of the weight that can be carried only the really vital points can at best be thus safeguarded, and even so only from those directions in which attack is thought most likely to be made; from other directions reliance is placed on the accuracy of the gunners' aim, during the necessary aerobatic manœuvres, being so poor as to be capable of being ignored. But here a fresh factor arises, and that is the growing improvement in the accuracy of gun sights. Those in use in the "Fortresses" are well known by the enemy to be excellent, and if that admittedly high standard can be still further improved, even the heavier armour may fail in its object. It is not solely a question of gun and armour; the accuracy of the gunnery also enters. This is important, as the Germans are shortening their training periods, lacking enough men for their air crews; the American training, like our own, is, on the other hand, long and thorough.

Hence, apart from our own aircraft carrying the 20 mm. cannon, we have reason to feel confident in the ability of our Ally to deal with the enemy even with the air equipment which Europe already knows so well, whilst, with the reportedly still more powerfully armed reinforcements being built in huge numbers on the other side of the Atlantic, enemy fighters will have a harder time still. As the air phase of the battle proceeds, the "softening" of the enemy by repeated bombing continues apace, and we may be allowed to hope that when this has reached its full strength the difficulties to be overcome in the later phases will be found to have decreased markedly.

State Rate Fixing

THERE are many difficulties to be overcome in the everyday life of the engineer, and in most cases he prefers to solve them for himself; but there is a tendency in some quarters to suggest that the only way of satisfactorily dealing with major problems is to elicit the services of a long-suffering Government. The matter has come definitely to the fore by a claim that production could be considerably increased by the appointment of State rate fixers, who would ensure equitable prices for every article to be manufactured. These proposals and a discussion on them at a meeting of the London Branch of the Works Management Association were described at some length in our issue of July 2nd, 1943. It is not without considerable misgivings that we contemplate the setting up of a body of State registered rate fixers, and there seems no cogent reason for bringing the State into one of the many functional services of the engineering factory without going the whole way, and ending up with State registered engineers and managing directors, who would subscribe to predetermined principles. Even if we assume for the moment that there is something to be said for standardising rate fixing on a national basis, we should like to consider the question of its feasibility without entirely revolutionising the present and tried methods of procedure.

It will readily be admitted that there are no two engineering firms that are similar in every respect; at one extreme will be found the large highly organised and highly functionalised enterprise, and, at the other, the small concern, often indifferently equipped, but with little overhead expendi-

ture, so that it can compete fairly effectively with its big rival. Assuming now that a rate has been determined for a certain article that is to be produced by both of these representative works, the question at once arises as to what machine tools will be used for the operations involved, as obviously the rate must be quite different for a modern automatic machine from that for an engine lathe of early vintage adapted for the particular work in hand. If the rate fixer proposes different rates for each type of machine his work will rapidly increase, and furthermore, he must be conversant with the general conditions as well or his price will soon prove to be unsuitable. But we must now go a stage further and consider the infinity of cutting tools that are at the disposal of the shop management, and the further query suggests itself as to whether a separate rate will be quoted for each brand of cutting tool. Even if the answer be in the affirmative, it must ever be remembered that a high-duty cutting alloy necessitates the appropriate power and speed for the machine to be used to advantage, and every engineer knows full well how many serious limitations are encountered so that he often cannot profitably benefit by the use of the best cutting tools. The problem for the universal rate fixer develops still further, for the permutations and combinations of machine and cutting tool are infinite, even granting that each factory has the best facilities for heat treatment and hardening. A fruitful source of friction between the rate fixer and the operator is to be found in the material used, material for which the specification of the customer is frequently sufficiently wide to allow for many variants. Will the paragon of a rate fixer predetermine rates that are equitable for all classes of mild steel, iron, brass, and the hundred and one other materials? If he can do this and ensure the elimination of clashes between management and man, he will indeed be one in a thousand, and he will not be content to remain a rate fixer indefinitely. Another serious complication has to be considered, one that is more baneful in its effects in wartime than in more normal days, and that is the subject of the numbers to be produced. The prices set for the peacetime requirements of the standing army in our national factories were probably reasonable, but without any change in method or equipment, but solely on account of the acquired speed of handling and movement, the prices have proved to be more than generous for the vast war output. We shall welcome an answer that will not upset labour. However perfect the price may be for ideal conditions, it is generally recognised that a contingency factor must be added to cover the indeterminate. Meticulous time study may easily be rendered valueless if this factor be too high. Perhaps the State rate fixer would eliminate it altogether. If so, he would let himself in for much trouble. We admit we have only touched the fringe of the difficulties that await those who seek to apply universal rates, but perhaps enough has been said to justify a policy of *festina lente*.

Having examined the possibilities, we are confronted with the definite question as to whether it is desirable to introduce State rate fixing at all, and we are bound to confess that we have serious misgivings on this score. It could hardly fail to lead to more bureaucratic interference in industry generally, while it might open the door for political pressure to be brought to bear on the manufacturer and it would tend to impose a heavy burden on the "small man," who largely relies on the understanding that exists between himself and his employees, each of whom he knows personally. It is to be feared that he might succumb in the struggle, and as he has proved his worth in wartime, and has been extremely useful in readily undertaking experimental work and expeditiously executing small orders which are not attractive to the more highly organised concerns, that would be a matter for regret. Furthermore, it is open to question whether largely increased production would actually be obtained, and it has yet to be proved that piecework is the best form of remuneration; indeed, there are many who would violently repudiate such a claim. Should State rate fixing be adopted, it might eventually justify the dictum *aegrescit medendo*, the remedy being worse than the disease.

Obituary

WILLIAM POLLARD DIGBY

IT is with deep regret that we learn of the death, on Monday, July 5th, at Bournemouth, of Mr. William Pollard Digby, of 26, Tudor Chambers, Wood Green, London, at the age of sixty-seven. He was in practice as a consulting engineer in London for many years, and his work covered a wide field. He received his education at the Guildhall School, Bury St. Edmunds, and studied later at the Crystal Palace Engineering School. About the age of twenty he went to America in order to study the electro-chemistry of chlorine, under Mr. A. E. Wolff, of New York, and on his return to this country he worked under Professor A. A. Kanthack and Dr. S. Rideal on the sterilisation of sewage effluents. From 1898 until 1901 Mr. Digby was engaged both in the manufacture and research connected with the making of hypochlorite of soda. In 1901 and 1902 he was placed in charge of the test bed, and later of the drawing-office of the Buck Henrici Engineering Company, of Berlin. On his return to London he was engaged on the design and testing of rotary engines. From 1903 to 1910 he was lecturer in engineering at the Crystal Palace Engineering School, and he also was engaged on inspection and research work. From about 1911 until quite recently Mr. Digby practised as a consulting engineer, specialising in electrical and mechanical work. Either by himself or in partnership he carried out many schemes, including hydro-electric plants and pipe lines. He also dealt with the developments connected with the transmission of mechanical vibrations, and was responsible for the designs of many power stations, pumping stations, and industrial plants. He designed the Vibragraph, and jointly with Mr. C. W. V. Biggs was responsible for the design of the Dionic water tester. Other apparatus he designed included a galvanic method of paint testing, known as the "Ulvanic" paint testing set, and the reflection meter. During the last war Mr. Digby served in the Territorial Force of the Royal Engineers and for the first two years of the war worked in the Explosives Department. From 1916 until 1920 he was attached to the Ministry of Munitions. In the course of his career he contributed many articles and letters to THE ENGINEER on those subjects in which he was personally interested. He was a member of the Institution of Mechanical Engineers, the Institution of Electrical Engineers, the American Institution of Engineers, and the Association of Consulting Engineers.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE MARTYRDOM OF SALOMON DE CAUS

SIR,—De Caus was engineer and architect to Louis XIII and was the chief landscape gardener of his day. His claim to a place among steam pioneers rests solely upon certain passages in a book he wrote called "Les Raisons des Forces Mouvants," published at Frankfort in 1615; second edition, Paris, 1624. All the relevant portions are given, translated into English, by Farey in his "Treatise on the Steam Engine" (1827).* Although he did not contribute anything to the theory or practice of the steam engine which assisted its development, he has been extolled to the skies by Arago and other French writers.

At the present day no one who is well informed in historical matters believes in the story that he was imprisoned on account of his ideas on the subject of steam; nevertheless, it was repeated in a popular book issued only a few years ago. As the full history of this very remarkable literary hoax has never been written, I have gathered all the facts I have been able to obtain about it.

An account of its origin is given in "La Vie et les Ouvrages de Denis Papin," by L. de la Saussaye and A. Pean (Paris, 1869). It appears that an article was published in the *Musée des familles* for March, 1834, signed "Sam," which contained a long letter, purporting to have been written by Marion Delorme to the Marquis de Cinq-Mars, dated February 3rd, 1641, saying that she, accompanied by the Marquis of Worcester, had just visited the prison known as the Bicêtre, where they saw de Caus, who had been shut up for three and a-half years as a madman, because he claimed that he could navigate ships and move carriages by steam. The story went through France like wildfire, being depicted in pictures exhibited at the Salon in 1845 and in the Paris Exhibition of 1855, and celebrated in poetry and on the stage.

It may be of interest to add that the Marquis de Cinq-Mars was a prominent courtier and conspirator in the reign of Louis XIII. He was executed in 1642. Marion Delorme was his mistress, and a leader of elegant Paris society.

The letter is a palpable forgery, for two reasons: first, there was no Marquis of Worcester in 1641; the title was not created until November 2nd, 1642, when it was conferred on the father of the author of the "Century of Inventions," who is clearly indicated as the companion of Marion Delorme on the supposed occasion. In 1641 he was known

* Farey gives the date of the Paris edition as 1623 which is a mistake. Otherwise, his account is correct.

as Lord Herbert; he was afterwards Earl of Glamorgan, and did not succeed to the marquisate until the death of his father in 1646. A second consideration, which clinches the matter, is the register of de Caus' burial at the church of La Trinité in Paris on February 28th, 1626—fifteen years before the date of the supposed interview with him. In it he is described as "Ingenieur du Roy," which identifies him beyond question. The funeral was attended with a certain amount of state, as it is recorded that two archers of the city were present.†

The first appearance of the bogus letter on this side of the Channel was in a book called "A Summer Among the Bocages and the Vines," by a Miss L. S. Costello (1840), who gave a translation, believing it to be genuine. Fifteen years later it was given in Lady Holland's "Memoir of the Reverend Sydney Smith," this time with a certain amount of caution, indicated by the words "have some reason to believe it is authentic." Then Smiles fell a victim and gave it wide publicity in his "Life of George Stephenson" (1857). By 1862, when he enlarged the book so as to include the life of Robert Stephenson, he had probably begun to entertain doubts about it, as he omitted it altogether. In the "Lives of Boulton and Watt," published in 1865, he said: "The story so often told of de Caus having been shut up in the Bicêtre turns out to be a fiction," and gave the correct date of the latter's death.

Meanwhile, Muirhead had come across the story and quoted the whole of the letter in his "Life of James Watt" (1858); but he was not deceived, and called it "an attempt at an impudent and fraudulent imposture." Dircks described it as a "forged letter" in a kind of supplement to his "Life of the Marquis of Worcester," called "Worcesteriana," of which 100 copies were printed in 1866. The last time it was put forward as a true story in a book of any importance was in Colburn's "Locomotive Engineering" (1871).

According to the "Vie de Papin," the name of the original perpetrator was S. H. Berthould.

C. F. DENDY MARSHALL.

June 30th.

SIXTY YEARS AGO: A MATHEMATICAL PRIZE

SIR,—In my comments on your recent article, it did not seem necessary to me to quote chapter and verse in dealing with events of sixty years ago which are now an established part of the history of mathematics. In order, however, to make certain of my statements, I had taken the precaution of going direct to the sources, namely, the *Comptes Rendus* of the French Academy for 1883, the life of H. J. S. Smith as given in Vol. I of his collected works published in 1894, and the life of H. Minkowski as given in Vol. I of his collected works published in 1911. I give the relevant details. The prize award was announced in the *Comptes Rendus* (Vol. 96) for April 2nd, 1883, and there was no reference to the subject in the issue for April 9th. In the issue for April 16th, pages 1095, 1096 contain a eulogy by M. Jordan on H. J. S. Smith, who had died February 9th, 1883. This is followed on page 1097 by a further statement from Monsieur Bertrand, on the award of the prize, in which, *inter alia*, he refers to the excellence and originality of the two prize memoirs and the impossibility of giving either of them second place. In the issue for April 23rd appears a short mathematical note written by Minkowski. Then in the number of THE ENGINEER dated April 27th, 1883, appears the assertion "... the Academy withdrew its award to Minkowski and gave the whole prize to Prof. Smith."

† See *Comptes-rendus de l'Academie des Sciences*, Tome 55 (Juillet-Decembre, 1862), page 34.

Minkowski's memoir was published by the Academy in 1884. Further, in Smith's collected works, published in 1894, the account of the matter is substantially as I have given it, and there is no mention of his having received the whole prize. I submit that the account which I have given confirms my statement that the original writer did not confine himself to remarks.

Your quotation from "The Dictionary of National Biography" refers to page 1096 of Vol. 96 of the *Comptes Rendus* as containing some remarks of Monsieur Bertrand about which the "D.N.B." says, according to your account: "Monsieur Bertrand offered a partial apology for this obvious injustice at the sitting of the Academy on April 16th, 1883." As pointed out above, his remarks appear on page 1097, but Monsieur Bertrand did not speak of any injustice nor did he offer any apology. In fact, in Smith's "Collected Works," Vol. I, page lxxi, reference is made to these remarks, *inter alia*, as rendering justice to Minkowski. I append a copy of Monsieur Bertrand's remarks. This should clinch the matter once and for all.

L. J. MORDELL.

The University, Manchester, 13,
June 30th.

[The significant sentences in Monsieur Bertrand's statement are as follows. Whether they are apologetic or not must depend upon the interpretation of that word. The first, dictionary, meaning of apology is defence or justification.—Ed., THE E.]

"Sur les trois Mémoires présentés au concours, le premier a été écarté comme insuffisant.

"Le deuxième suivait exactement la marche tracée par M. Smith et donnait la démonstration de ses énoncés; celui des Commissaires qui a accepté la tâche d'en faire l'examen a pu, sur ces indices, deviner le nom de L'auteur. Peu importait, d'ailleurs, que le Mémoire fût de M. Smith ou inspiré par le travail depuis longtemps livré au public par le savant professeur d'Oxford: it méritait incontestablement le prix.

"Un troisième Mémoire résolvait la question; il était difficile que deux géomètres assez habiles pour parcourir ce terrain élevé, mais un peu étroit, ne s'y rencontrassent pas sur plus d'un point. Les méthodes avaient de l'analogie, mais chaque Mémoire portait la marque d'un esprit original et distingué; tous deux étaient excellents et il semblait impossible de donner à l'un d'eux le second rang."

Sixty Years Ago

A SECOND SUEZ CANAL

THE success of the Suez Canal inspired in some quarters the idea of constructing a second one in the same neighbourhood, with the object of affording relief to the first, and, incidentally, it would seem, of establishing a competitive waterway and thereby inducing the existing Suez Canal Company to lower its charges. For a time de Lesseps refused to listen to the suggestion and claimed that his concession gave him virtually a monopoly of the construction of ship canals in Egypt. Pressure was exerted upon him, and he consented to widen and deepen the existing canal. That scheme gave little satisfaction, and negotiations were begun by the British Government for the construction of a second canal. On July 11th, 1883, Mr. Gladstone made an authoritative statement on the subject. A second canal, he said, was to be constructed forthwith, funds amounting to £8,000,000 being advanced for the purpose by the British Government. A paper was laid before Parliament containing the heads of a provisional agreement with de Lesseps. According to this document, the Suez Canal Company was to construct a new canal as far as possible parallel with the existing one and of a width and depth sufficient to meet the needs of British shipping. The canal was to be completed by the end of 1888. The agreement also covered a modification in the transit dues and made provision for an increased part to be played in the control of the canal company by British directors and officers. Commenting upon the agreement in our issue of July 13th, 1883, we expressed the view that it was much too favourable to the canal company, which stood to make a handsome return from it without incurring any risks. We suggested that de Lesseps was being allowed to take a hand in the scheme simply in order to avoid political trouble, but contended that we were going to pay too much for peace and quietness. We could supply the engineers as well as the money for the work, and should do it for ourselves.

Accidents on British Railways in 1942

THE annual report for 1942 of Sir Alan Mount, the Chief Inspecting Officer of Railways, which was issued on Monday, July 5th, shows that there were remarkably few train accidents of a serious nature, notwithstanding an increase of about 20 per cent. in the number of passengers carried, as compared with 1941. The forty-six fatalities among passengers, railway servants, and other persons compare with the average of thirty-nine for the five-year period 1935–39. Twenty-eight of them occurred in two accidents. Among passengers the liability to casualty in train accidents was one killed in some 60 millions carried, and with regard to servants the passenger and freight train miles worked were about 43 millions per fatality. In 547 train accidents of all kinds, 233 were caused by human failure. The year opened with abnormally cold weather, but in handling the exceptional traffics the difficulties resulting from restricted lighting and shortages of power and staff were materially alleviated by a very mild autumn and winter. Throughout the year a high standard of safety was maintained. In accidents connected with the movement of railway vehicles, exclusive of train accidents, 113 passengers were killed, as compared with an average of 68 for the five-year period 1935–39. Of this number, 83 occurred in falling from platforms and trains and when entering or alighting from trains, as compared with 81 in 1941 and with the annual average of 53 during 1935–39. Of the total fatalities, 58 occurred during black-out, as compared with 52 in 1941, and restricted lighting was referred to in 24 cases. The women employees now total over 100,000, as compared with some 25,000 before the war. They have shown remarkable aptitude for their new duties and are responsive to instruction intended for their personal safety. Railway servants suffered 284 fatalities, including 4 women, in movement and non-movement accidents, as compared with 314 in 1941 and with the average of 228 for the five-year period 1935–39. There were 586 serious casualties to servants in the black-out, as compared with 563 in 1941, but fatalities decreased from 85 to 70; of the total, restricted lighting may have contributed to 182, compared with 201 in 1941. Everything possible is being done to increase efficiency and safety at night within the limits that war conditions prescribe, and it is hoped that improvements in lighting, which have recently been agreed, will be reflected in the figures for 1943.

RESERVOIR FOR NORTH CAROLINA.—In order to provide water storage and fire protection for naval bases and war industries, the Federal Works Agency of America has announced that steps will be taken at once to expedite the construction of a 3,000,000-gallon untreated water reservoir in North Carolina. Two types of reservoirs are being designed, one to be of reinforced concrete construction, set partly below ground, and the other to have gravity type concrete walls for which no reinforcing steel will be necessary. Contractors will be asked to submit proposals for both types of reservoirs, but reinforced concrete construction will be stipulated in the contracts if the steel can be obtained.

Aluminium in Post-War Reconstruction

By ROLT HAMMOND, A.C.G.I., Assoc. M. Inst. CE..

No. II—(*Continued from page 16, July 2nd*)

AT this point it may be interesting to describe the Philips spot welder, type E 1500, illustrated by Figs. 1 to 5 inclusive. This machine has been designed specifically for the welding of aluminium in thicknesses varying from two sheets of 22 gauge material to two sheets of 10 gauge material. Fig. 1 shows a general view of the welding machine. Forging pressure is applied by the air cylinder mounted on the top arm, the electrodes being water cooled. Air is supplied at a pressure of 100 lb. per square inch, and the flow of cooling water is about 30 gallons per hour. The water passes through a copper tube within the electrode stake, flows inside the spot-welding electrode, returning *vid* the space between the copper tube and the inside diameter of the electrode holder to the outlet pipe at the top of the stake.

A close-up view of the welding head is shown in Fig. 2. It has been designed to ensure rapid follow-through of the electrodes when welding aluminium. It is essential that the head should be of very low inertia, following up the collapse

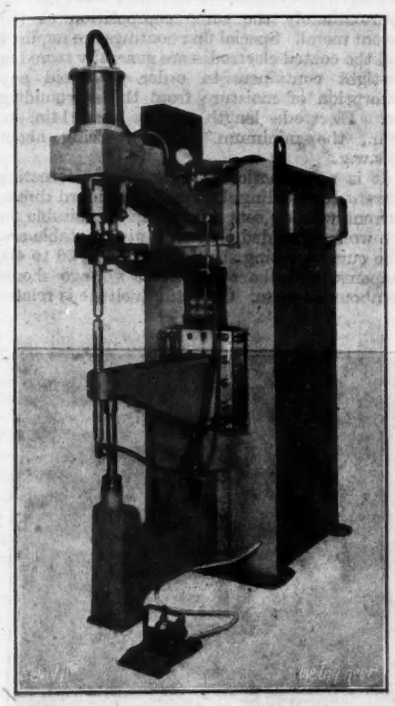


FIG. 1—PHILIPS SPOT WELDER

of the material being welded with the utmost possible speed. The electrode will thus remain in close contact with the sheet during the period when the metal decreases in thickness. This spring-loaded head corresponds to an automatic centre punch, a device in which the punch is suspended on a spring and a plunger moves very rapidly to mark the material. In a similar manner the spring-loaded head of the welding machine can follow up the spot weld, irrespective of the air pressure in the head, thus avoiding the need of relying on air expansion to move the head those few thousandths of an inch required for quick follow-through.

An interesting design feature is the pair of roller guides at the rear of the spring. These centralise the electrode and are adjustable to take up any side play. Adjustment of the spring is effected by means of the tommy bar holes in the spring cup, the brass plate in front of the spring being graduated to coincide with the outer rim of the cup. This enables spring pressure to be recorded instantly.

When the base of the cylinder rises, the switch on the left comes into action, thus making contact. Sequence of operation can be determined at loads ranging from 500 lb. to 1000 lb., the switch being set so that welding takes place at any desired pressure between these limits. After welding, air pressure builds up in the cylinder and imparts forging pressure to the weld. By employing condensers, welding takes

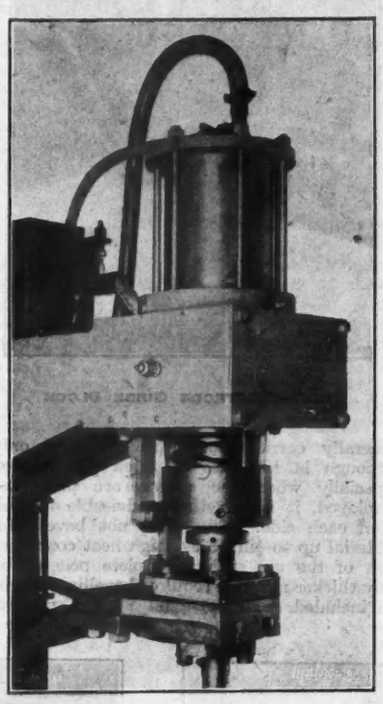


FIG. 2—WELDING HEAD

place in about 2½ cycles, and forging pressure, sometimes described as "dwell" on the electrodes after welding, takes place in about 8 cycles.

The complete equipment is shown in Fig. 3. To the left is the rectifying transformer, feeding rectifier cubicle, and mercury arc bulb. Voltage range of the transformer is from 230 to 500 volts, tap change being effected by means of coarse and fine tap change hand wheels on the front of the transformer, the left-hand wheel being the fine adjustment and the right-hand wheel the coarse adjustment. Supplied with three-phase alternating current at 400 or 440 volts, the transformer is oil cooled. Next to it is the rectifier cubicle containing a mercury arc bulb. The unit comprising the rectifier and transformer is made by the Nevelin Electric Company.

On the right can be seen the condenser unit. Operational sequence is as follows:—Alternating current is supplied to the transformer, which feeds the rectifier. From the latter direct current flows to the condenser bank, which is discharged at a predetermined voltage to the welding transformer incorporated in the welding machine. This, in turn, passes current through the aluminium sheet to be welded.

Knife switches on the condenser banks are shown in Fig. 4. These control the capacity of the machine by switching on and off to the main

FIG. 4—CONTROL OF CAPACITY BY KNIFE SWITCHES

bus-bars, by which means any condenser capacity between 4000 and 28,000 microfarads may be obtained. This variable capacity is used for welding various thicknesses of aluminium sheet, and acts in conjunction with the voltage regulation of the mercury arc rectifying unit. Two banks of condensers at 400 volts are required for welding two sheets of 22 gauge aluminium, and six banks of condensers at 500 volts for two sheets of 10 gauge aluminium. Condenser capacity for intermediate thicknesses is determined by experiment. For very coarse adjustment of machine settings the number of condenser banks is varied, but for finer settings the tap change switches on the rectifying transformer would be used. Thus current can be adjusted for any thickness of aluminium within the range of the machine, condenser charging voltage being variable, ensuring exact settings over a very wide range.

The control panel shown in Fig. 5 gives some

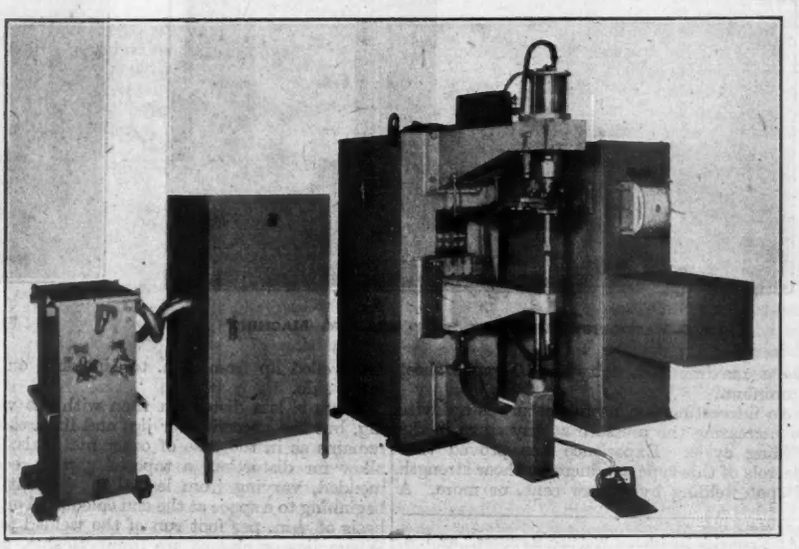


FIG. 3—COMPLETE SPOT WELDING EQUIPMENT

idea of the simplicity of operation. Repeat operation is obtained by pressing the button marked "Repeat," the graduated knob being set to the appropriate time between welds. Speed range in this repeat operation is between ten and forty spots per minute, the operator keeping the foot switch depressed while the machine continues spot welding automatically until he removes his foot and releases the switch. Thus completely automatic mechanical control of welding is achieved, thereby ensuring consistent and uniform work.

A special Metrovick aircraft type spot welding

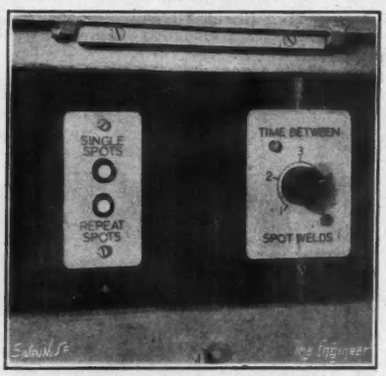


FIG. 5—CONTROL PANEL

machine is shown in Fig. 6. This is equipped with Ignitron control, which permits a high initial current to effect the weld, followed immediately by reduced current to give it the appropriate heat treatment.[4] Values of initial and final current can be varied independently. Twenty transformer tappings, combined with phase shifting, give infinite variation of the welding current throughout the whole process. The machine illustrated operates at 650 kVA. It exerts a maximum pressure of 2000 lb. and

special air-operated machine, of similar make, is shown in Fig. 8, and Fig. 7 shows a view of the electrode guide block and spot light on the aircraft welder.

Considerable progress has been made in recent years in the application of electric arc welding to aluminium alloys. It is not generally possible to use this process in any position except with the work horizontal. Welding is

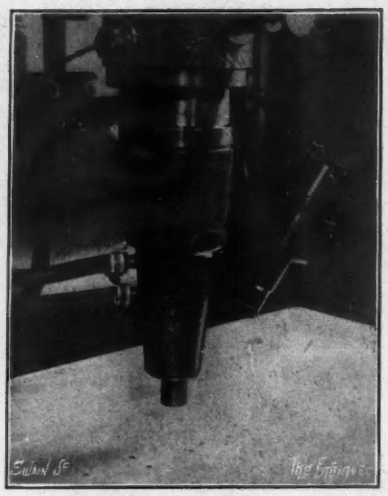


FIG. 7—ELECTRODE GUIDE BLOCK

generally carried out from one side only, although in the case of thick plates, more especially when the carbon arc process is employed, it is sometimes advisable to weld from each side. Edges are not bevelled in material up to ½in. thick, high heat concentration of the arc giving complete penetration. Any thicker material requires bevelling, to give an included angle of about 90 deg. with an unbevelled lip from $\frac{1}{16}$in. to ⅛in. deep on the lower side.

There is less distortion than with gas welding, but the necessity for jigs and fixtures still remains as in the case of other materials. To allow for distortion, a tapered gap is recommended, varying from less than $\frac{1}{32}$in. at the beginning to a space at the end calculated on the basis of $\frac{1}{32}$in. per foot run of the welded joint. Where jigs or clamps are impracticable, components are tack welded at intervals of between 4in. and 8in., with a parallel gap varying from $\frac{1}{16}$in. to ⅛in. wide. Molten aluminium, deposited from an electric arc, is highly fluid, and it is therefore usual practice to provide a backing strip in order to prevent excessive penetration. This backing strip may be of iron or copper, and should be provided with a shallow groove immediately below the weld. A slight bead is thus provided on the underside of the weld, where there is liable to be shrinkage due to cooling.

Electrode core wire generally consists of the 5 or 12 per cent. silicon alloy. Modern research has provided electrodes of alloyed and pure aluminium, in which the weld metal is of approximately the same composition as the parent metal. Special flux coatings are required and the coated electrodes are generally stored in air-tight containers in order to avoid any absorption of moisture from the surrounding air. Electrode length varies from 14in. to 18in., the minimum diameter being about 12 s.w.g.

Electrode Size and Current Range

Thickness of material, inches.	Gauge of electrode.		Current range, amperes.	Plate preparation.
	S.w.g.	Inches.		
0·062–0·08	12	0·104	40– 55	Close butt
0·081–0·10	10 or 12	0·116	55– 65	,,
0·102–0·12	10	0·128	65– 75	,,
0·125–0·15	8 or 10	0·144	75– 90	,,
0·156–0·18	8	0·144	90–100	,,
0·187–0·22	8	0·160	100–145	$\frac{1}{16}$in.
0·25 –0·30	6	0·192	145–190	⅛in.
0·31 –0·37	6	0·192	190–230	$\frac{1}{16}$in. or bevelled 70° with $\frac{1}{16}$in. step
0·37– 0·45	4	0·252	230–300	$\frac{1}{16}$in. or bevelled 70° with $\frac{1}{16}$in. step

It is not practicable to employ alternating current for welding, but many standard direct-current welding sets are eminently suitable for the work, provided that they give a stable arc. The current rating should vary from 50 to 400 amperes, and the open-circuit voltage should be about 60 volts. Operating voltage is related to the arc length and to the type of electrode used. Those who contemplate using the electric arc process for welding aluminium may be interested in the table above, which gives the recommended electrode sizes, current range, and methods of plate preparation for various thicknesses.

It will be noted that the currents are generally within the lowest range of the smaller types of welding generators, which may entail some difficulty in maintaining a stable arc. In order

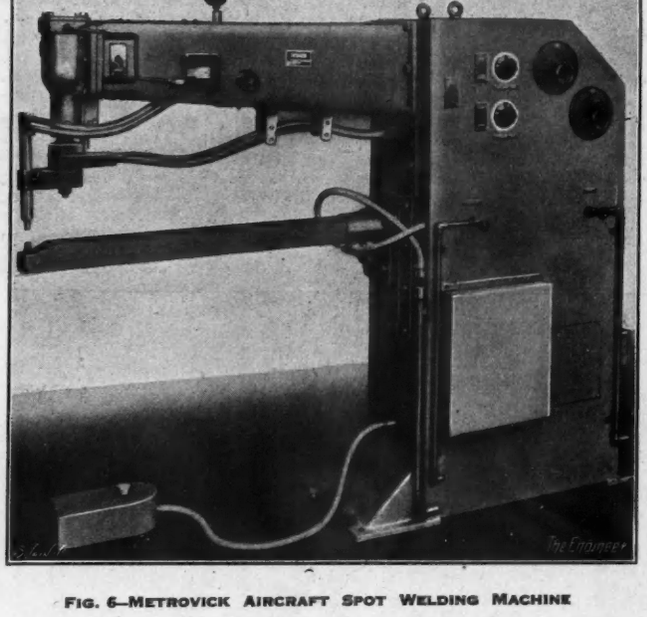


FIG. 6—METROVICK AIRCRAFT SPOT WELDING MACHINE

FIG. 8—AIR-OPERATED WELDING MACHINE

has a maximum capacity for 10 gauge sheet aluminium.

An interesting and useful feature is a device for increasing the pressure at any stage in the welding cycle. Experience has proved that controls of this type can increase shear strength of spot welding by 30 per cent. or more. A

[4] "Metrovick Resistance Welding Machines," by J. A. Dorrat, A.M.I.E.E., in *The Metropolitan-Vickers Gazette* for September, 1940.

to improve arc stability, it is recommended that a resistance of between ¼ and ½ ohm should be connected in series with the arc. Further slight improvement in stability may also be effected by changing the polarity. The electrode is generally connected to the positive terminal, but a trial should be made on each particular job.

Arc length should never exceed ⅛in., and 1/16in. is considered to be satisfactory. A long arc has a tendency to wander, and is difficult to maintain, with increased liability to spatter. Although fumes tend to obscure the arc, experience soon enables the correct length to be gauged with accuracy.

Preheating the work to a temperature of at least 150 deg. Cent. reduces the tendency to porosity, and preheating is strongly recommended for heavy work. Care should be taken to avoid temperatures in excess of 350 deg. Cent., for at this temperature excessive melting is liable to occur. A gas flame or carbon arc may be used for local preheating, but for castings and general work a furnace is preferred.

The downhand procedure is generally adopted for the welding of aluminium, the electrode being held at right angles to the work, but slight variations in the angle are permissible. Variation from the vertical should never be more than 20 deg. It is interesting to note that there is sometimes difficulty in starting an aluminium arc weld, owing in part to the speed with which the metal melts, and to the insulating properties of the flux coating at the tip of the electrode. The arc should be struck as near as possible to the point where welding is to begin, welding being much more rapid than in the case of steel.

The electrode should be moved along the joint without weaving. In the case of thick material a bead should be built up and the electrode moved only back and forth in the direction of the weld. Skilled welders may achieve excellent results with slight weaving on thick plates, but it is considered preferable to use large electrodes without weaving. The high welding speed employed results in an electrode consumption of from two to three times that of mild steel electrodes of the same size.

Metallic arc welding of aluminium tends to form larger crystals in the weld itself compared with a gas weld. Cold working should be followed by local annealing at a temperature of about 400 deg. Cent. to restore the ductility of the metal.

The carbon arc process is less flexible than the metallic arc or gas welding processes, but can be used successfully for straight butt joints. It is particularly suitable for thin material, but tends to cause gas porosity. In this process a flux-coated filler rod is used, the tip of the rod being inserted between the edges of the metal and the carbon electrode.

(To be continued)

Problems of Employment*

INTRODUCTION

Efficiency.—The purpose which Great Britain needs to set before itself can be briefly defined, in its economic aspect, as the achievement of the nearest possible approach to "full employment"† at a high and steadily rising standard of living. It is by now clear that this purpose cannot be achieved unless three indispensable conditions can be met. There will have to be, first, extensive Government measures of an "anti-cyclical" character, designed to prevent those fluctuations in economic activity which have hitherto been accepted almost as if they belonged to the order of Nature; secondly, extensive structural adjustments of the British economic system designed to bring productive capacity and the skill of the working force, managerial, technical, and manual, into a right adjustment to the needs of the market and the opportunities presented by scientific and technical change; and thirdly, the highest attainable efficiency, based on a co-operative will among all sections of the producers to achieve maximum production at minimum real cost. These objectives require that a much better use shall be made than has been made in the past of the human material available to industry. They require, for example, extensive measures of education and training, including the retraining of those whose skills are superseded by changing techniques or changing currents of demand; the abolition of all forms of blind-alley employment and misuse of juvenile labour; and the achievement of a high degree of flexibility and initiative in every part of the industrial system. Accordingly, they require many sacrifices of cherished practices on the part of employers and trade unionists alike—practices of value largely in relation to an industrial situation in which the directors of industry fear the limitations of the market and the workpeople the shortage of jobs; and sacrifices likely to be made much more readily when there is every prospect that they will be richly rewarded by the higher standards of living and amenity which the new outlook and policy will make it practicable to achieve.

Full Employment.—The post-war economic system in Great Britain must be so organised as to comply as fully as possible with the condition that has come to be known as "full employment." There must be no return to the disastrous waste of man power which characterised the period between the wars. Every necessary step must be taken to expel from our midst the two forms of unemployment which were, between them, mainly responsible for this waste. Cyclical unemployment must be combated by measures, national as well as international, designed to bring under control the devastating fluctuations of economic activity involved in the trade cycle; and, at the same time, structural unemployment must never be allowed to reappear in the forms which produced the depressed areas and left many thousands of men to languish year after year upon pittances almost without hope of employment. To set out to abolish these two forms of unemployment is not, of course, the same thing as to abolish unemployment itself; nor should "full employment" be taken to mean a situation in which no unemployment will exist. It should, however, be taken to mean a state of affairs in which, by effective measures to deal with the trade cycle and to make industry more easily and rapidly adaptable to necessary structural changes, lack of work will be reduced to a problem which will affect only such numbers and for periods of so short duration as to inflict no human damage with which an adequate plan of social security cannot competently cope.

Unemployment beyond these limits we must set out to eradicate, for both humane and economic reasons. Industry after the war will need not only efficient service, but also the service of every available worker. Great Britain will not be able to afford not to make full use of its limited labour resources. This will be true not only of the period of physical reconstruction and reconditioning, but also in the long run. The demand for higher standards of living and amenity will be such as to require the services of every available worker up to the point at which more leisure is to be preferred to greater wealth. The demands of leisure, and not the limitations of the market, must be made to set the bounds to the volume of useful employment.

Public Confidence.—Industry after the war must be so conducted by all those who are concerned in its operation in any capacity as to command the confidence of the people, as workers, as consumers, and as investors. Fuller publicity is an indispensable instrument for the creation of this new spirit of confidence—candour towards employees in laying bare the financial aspects of the affairs of firms and business associations, candour towards investors in the presentation of accounts, and candour towards the consuming public in matters of price fixing and the regulation of economic relations.

Labour, Industry, and the Public.—Of course, the new spirit will call for much more than this. Such wartime developments as the institution of Joint Production Committees—which are themselves an extension of the principle of Works Councils, such as existed in a number of firms before the war—will have to be continued, extended, and adapted to post-war conditions. Whole-hearted recognition of trade unions will need to become universal. Business concerns and trade unions will have to accept the necessity of squaring their policies in negotiating about wages and conditions of employment with the overriding authority of the nation; similarly business men, wherever they set out to determine in concert either prices or volume of output for their products, and trade unions, in attempting to regulate the conditions of employment and the demarcation of trades, will have to submit their decisions to the scrutiny of impartial authorities representing the public interest. This necessity holds good fully as much in the sphere of wholesale and retail distribution as in that of manufacture. Employers' associations and concerns of every sort, and also trade unions and professional bodies, will have to work under codes of conduct in harmony with the new spirit and purpose which we have attempted to define in the preceding paragraphs. The logical complement to a guarantee of social security in sickness, unemployment, or old age is the guarantee of a minimum living wage to those at work; and the necessary concomitant of industrial regulation by the producing interests is a readiness to defend their doings at the bar of public opinion. If our country after the war is to aim steadily at a rising standard of living based on the highest productive efficiency and flexibility and on "full employment," it will not be able to afford to tolerate any practices which either diminish flexibility or restrict production below the optimum level. Industry will need to work under a public code of conduct based upon these objectives; and on no other terms can the confidence of either workers or consumers in the integrity of those responsible for it be secured, or trade unions and employers' associations be persuaded to concern themselves no less in promoting industrial efficiency than in the direct defence of their members' immediate interests.

Trade unions, equally with employers, will be called upon to accept a code of conduct. Their place in the life of the community depends, no less than that of management, on the squaring of their purposes and methods with the public interest in efficient and unrestricted service, and in securing the confidence of the consumers in their integrity and public spirit. Where for any reason trade union practices stand in the way of efficient service under fair working conditions, means will have to be found of securing their abandonment, no less than the abandonment of restrictive practices on the employers' side. Trade unionism can afford no more than any other section of the community to rest under imputations which, arising from the existence of indefensible regulations here and there, react inevitably on the attitude of the consumers towards the entire movement.

Profits.—Confidence is, indeed, at the root of the matter. A great many of the responsible leaders of industry to-day are intent, above all else, on serving the public to the best of their power by high and efficient production, and on dealing fairly by those whom they employ by avoiding such evils as "standing off" and discontinuity of employment as well as by paying good wages and ensuring good conditions in their establishments. It is emphatically not the case that most employers, or most managers, are moved exclusively by considerations of private profit. Profit, however, is, under the present system, to a large extent both a test of efficiency and a condition of survival; and we know of no alternative to it as a means of meeting the risks of private enterprise or of keeping the risk-taking capitalist up to the scratch. What is

* Excerpts from a Statement compiled after a private conference held under the auspices of Nuffield College, Oxford, on "Problems of Employment and of the Relations Between Government and Industry after the War." Published by Oxford University Press. London: Humphrey Milford. Price 2s.

† By "full employment" is meant a state of affairs in which the number of unfilled vacancies is not appreciably below the number of unemployed persons, so that unemployment at any time is due to the normal lag between a person losing one job and finding another. "Full employment" in this sense cannot be completely attained as long as there exist structural maladjustments needing to be put right. Indeed, it can probably never be reached completely in normal times, but this statement is based on the belief that it is the correct object to aim at, and that a reasonably near approach to it can be actually achieved.

unjustified in this connection is monopoly-profit—the use of economic power to exact an excessive price from consumers or to subject the workers to unfair conditions of employment. Such practices must be prevented, if public confidence in industry is to be secured, and the man of integrity, whatever his position in industry, will recognise the justice of this step, and the need for public scrutiny in order to ensure that economic power is not abused.

FLEXIBILITY AND TECHNICAL EFFICIENCY

Flexibility in the use of labour is destined to be a factor of the first importance in the adaptation of industry to changing post-war needs and techniques. Trade union organisation necessarily arises out of, and largely reflects, the established technical methods, which have given rise to a particular balance of skills and to a certain demarcation between trade and trade. As technical conditions alter, new forms of skill have to be developed, and some older skills become obsolete or in less demand. As long as, for each trade, the fear of unemployment or alternatively of degradation to a lower class of work exerts a dominating influence on policy and attitude, there is bound to be much opposition to industrial changes which, even if they lower costs, do so at the expense of large groups of skilled workers. This opposition will become much less formidable the moment the workers concerned have been induced really to believe that the policy of "full employment" has been adopted and will be adhered to steadily in face of impending crisis or depression. It may disappear altogether if the workers can be induced to believe, not merely that they will not be left to fester in unemployment, but that their welfare and continued usefulness to the community are to be regarded as primary objectives of industrial policy. If once the workers can be made to believe that they are to be treated as real partners in industry, and not merely as hired hands, and that "full employment" is to become the accepted basis of national economic policy, no great difficulty is likely to be met with in negotiating with the trade unions a series of agreements which will not only make an end of such restrictions as obstruct technical progress, but will also positively enlist the workers and their representatives as the allies of technicians and managers in introducing improved methods of production.

Industry and the Civil Service.—There is a kind of interference that inevitably defeats its own purpose by removing the sense of responsibility from those on whom the success or failure, the efficiency or inefficiency, of the enterprise must necessarily depend. Parliament must find ways of ensuring the compliance of industry with public needs without badgering those who are responsible for its conduct. There must, indeed, be a code, to which every participant in industry will be called upon to conform, and this code must be made as precise as possible; but within its requirements the industrialists, employers, managers, and workmen together must be left to manage their own affairs. The degree of detailed interference with day-to-day operations which has to be accepted in war would be intolerable in time of peace. It has, of course, to be recognised that the methods applied under war conditions have had to be improvised, and that it should be fully practicable to work out better methods for such forms of State control as are destined to outlive the war. It is of the greatest importance that careful attention shall be given to this matter, in order to devise a technique of control which will be at once effective and reasonably simple from the standpoint of the business man as well as of the civil servant. It is not desirable that either the managerial or the operative staffs of public enterprises should be employed under conditions modelled on those applying to ordinary civil servants, or that the day-to-day management of such enterprises should be subject to the traditional forms of Treasury control.

It will in effect be necessary to develop a new kind of public administration to deal with the State's new and expanding functions in the industrial field. This will mean recruiting new types of men and women, and adopting an essentially different technique of administrative team work.

Industry and Education.—Stress must be laid on the great contribution which can be made to industrial efficiency by attention to the right training of those who are to enter the service of industry and commerce. This applies not only to managerial and technical staffs and to skilled workmen, but also to the less skilled operatives. For the higher and more specialised posts the need of industry is for greatly improved arrangements both for technical and professional education and for training in research, and also for a high standard of cultural equipment. For the routine jobs industry can for the most part provide its own training, and its main call upon the educational system is for the highest possible standards of intelligence and mental adaptability in those who enter its service. It would have been necessary to enlarge further upon this matter had it not been the subject of a special statement already issued by a group of signatories who met under Nuffield College auspices. In view of that statement, it is enough to say here that in post-war Britain labour will be scarce, and young and easily adaptable labour scarcest of all, and that it is accordingly of the greatest possible importance to the nation that none of it shall be allowed to run to waste or be deprived of the opportunity of rendering the highest quality of service that is within its capacity. The educational system should be directed to fostering above all else qualities of initiative and mental adaptability in the coming generation, and upon its success in fulfilling this mission the efficiency of industry, as well as the cultural achievement of our civilisation, is bound mainly to depend.

The Problem of Distribution.—Technical efficiency and flexibility are imperatively needed, not only in manufacturing industry, but also throughout the field of wholesale and retail distribution. It is impossible to dismiss as unfounded the widespread belief that there is in many cases far too wide a margin between the price received by the producer and the price which the consumer is called upon to pay. It is difficult not to believe that with better organisation and less unnecessary transport at intermediate stages the costs of distribution could be drastically cut down without any equivalent fall in the quality of the service supplied. Methods of distribution have grown more and more complicated and have come to involve in many fields very expensive forms of advertising and display which this country may not be able to afford after the war. No doubt the carrying into effect of substantial economies would involve a large release of labour from employment in the distributive trades. But this, so far from being regarded as a disadvantage, ought, under a policy of "full employment," to be looked on as an opportunity for expanding production. To defend the waste of labour in the processes of distribution on the ground that it "provides employment" is to fall into the perilous fallacy that employment, and not production of useful things, should be the object of national economic policy.

FULL EMPLOYMENT

The problem of cyclical unemployment has two aspects—domestic and international. It is clearly not possible for any country which depends on international trade to rid itself entirely of the effects of cyclical unemployment by purely national measures; for depression in overseas markets is bound to react on industry in ways that cannot be completely offset. In order to cure cyclical unemployment with any completeness it is necessary for the nations, or at all events for the great trading nations, to act in concert, each taking part in international measures and taking steps in its own country to counteract such elements of depression as fall within its range of control. If the leading nations act together in this way there is no reason why they should not succeed in reducing cyclical unemployment to very much smaller proportions. In what is here said about the measures that need to be adopted in our own country, this statement must be understood as urging the adoption of parallel measures in other countries, with, of course, such variations as are dictated by differences in national conditions.

The effective control of the trade cycle and the acceptance of a national policy of "full employment" clearly involve the adoption of public measures for steadying, and where desirable increasing, the rate of investment, which represents the demand for capital goods, as well as for maintaining consumption.

These measures have both a monetary and a directly industrial aspect. There is wide agreement that credit policy, including the broad direction as well as the total amount of credit supplied, being a matter of public concern, should be determined in accordance with considerations of national policy. It follows that the Bank of England, whether or not its status as a public corporation should be placed on a formal basis, should continue to act under the direction of the Government in matters of monetary policy. It is also evident that Government direction of the banking system as a whole, including the commercial banks, should be exercised with a view to ensuring that the policy of "full employment" shall not be hindered by any shortage or misdirection in the supply of credit.

Public Works Policy.—The credit which is to be made available through the banking system can be used effectively only if it is spent, and spent in the right way. This involves public action to stimulate investment in capital goods in accordance with a nationally approved policy of economic development. We hold that public works, including both works undertaken directly at the orders of public bodies and works undertaken by private agencies or contractors as a result of public encouragement (*e.g.*, in the field of building), constitute a valuable means of maintaining the level of such investment in periods of threatened business depression, but that exclusive reliance on such works in their traditional forms is apt to lead to lopsided development, and to fail in applying the required stimulus to industry over a wide enough field.

The disadvantages appear at their worst where the State, in an attempt to provide as much employment as possible without invading the domain of private business, resorts to mere relief works hardly superior in productive value to the proverbial digging of holes in order to fill them up again. Such relief works merit unqualified condemnation, and are to be distinguished sharply from public works carried out under normal conditions of engagement and by normal methods of contract. The purpose of public works, as distinct from such relief works, is not merely to provide employment, but to add to the community's stock of productive assets and other capital goods and therewith to maintain the demand for consumers' goods and capital goods alike.

The field over which the State should be able directly to influence the course of capital expenditure appears to be divisible into seven groups:—

(*a*) Direct State employment, including employment by State-owned public corporations and by local authorities aided by State grants.

(*b*) Direct public orders, carried out by private contractors for the State or for local authorities or public corporations.

(*c*) State assistance in the establishment or extension of private businesses, including such facilities as have been accorded in the past in the special areas through the development of Trading Estates and such forms of help as may be adopted as part of a national policy of influencing and controlling the location of industry.

(*d*) Private orders resulting from public facilities for the supply of capital or credit to enterprises needing such help, and deemed worthy of it in the public interest.

(*e*) The use of the instrument of taxation in such ways as to encourage capital expenditure at times of low economic activity and, where necessary, discourage it in periods of incipient inflationary boom.

(*f*) Public accumulation of stocks of commodities, with the correlative of release of such stocks at appropriate times, in order to steady market conditions.

(*g*) The negative aspect—prevention of

capital expenditure regarded as wasteful or as less desirable than alternative forms of investment under the previous heads.

It is a point of substance that, apart from the special case of building, which is dealt with elsewhere, the demand for capital goods is very highly concentrated upon certain types of industry—especially transport and public utilities—and it is evident that an application of the public corporation principle to cover a number of the industries and services which are among the largest consumers of capital goods, both for extensions and for replacements, would give much more scope for the pursuance by the State of an investment policy calculated to promote "full employment."

It has, of course, to be recognised that any policy designed to regulate the volume of investment in capital goods requires very careful attention to the time factor. A considerable time is bound to elapse in most cases between the decision to embark on any important project of capital construction and the actual execution. This delay arises both because it takes time to prepare proper plans and because extensive consultation of interests and groups likely to be affected—for example, local authorities—is usually necessary before the work can be begun. Any attempt to improvise such schemes in a hurry is bound to lead to misdirection of effort, and will also commonly involve excessive costs and serious administrative complications. Accordingly, plans of capital development need to be worked out well in advance, in consultation with the bodies concerned in them, and then held ready to be put promptly into execution when the appropriate moment arrives. This necessity exists at all times; in relation to projects which are to be carried out as soon as possible after the war, it points to the need for working the plans out now, not merely in general outline, but in considerable detail, and for reaching agreement in advance with the bodies whose help will be required in carrying them into effect.

It will be desirable for the Government to adopt a radically new method of presenting the national accounts. Capital expenditure, including capital expenditure incurred for the purpose of maintaining real investment, should not be included in the ordinary Budget, or expected to be balanced by revenue during the current year. There should be a State capital "Budget," presented to Parliament separately from the ordinary Budget, and embodying public plans of economic development framed in such a way as to ensure a progressive rise in standards of living and amenity. Such a Budget would, of course, not need to be covered by taxation. It would be a statement of the proposed investments to be made on public account during the financial year, accompanied by a White Paper reviewing the state of the national economy, the estimated size of the national income, the amount of investment regarded as likely to be forthcoming from private sources, the contribution to be made to the total of investment from public sources, and the anticipated level of consumption. It would thus provide the opportunity for a general stocktaking of the nation's economic affairs, whereas the ordinary Budget presented by the Chancellor of the Exchequer would deal with the means of meeting current expenditure, other than capital expenditure financed on loan account. Interest charges on such capital expenditure would, of course, be met out of the ordinary Budget, as far as they were not balanced by receipts, and it would be possible to provide out of taxation for the writing-off of perishable capital assets and for the repayment of any part of the capital sums expended in earlier years. What is neither necessary nor desirable is to mix up capital and current items in a single Budget, or to expect the Treasury, which is the department concerned with budgeting in the ordinary sense and with using its power over the other departments to check every form of waste, to assume the essentially different task of supervising and controlling the constructive investment policy which we are proposing that the State shall pursue.

A National Development Board.—As an integral part of the machinery that will be required for the successful execution of the policy here proposed, the State should set up a National Development Board, to which should be entrusted the control of funds available for public investment, as well as the functions now performed by the National Debt Commissioners, the work relating to local loans, the functions of the Public Works Loans Board, and the supervision of all State investments in productive enterprise, together with the function of licensing such capital issues or other forms of capital expenditure as may be made subject to public control. The National Development Board, or a parallel body acting in close association with it, should be made responsible for the control of the main forms of overseas investment, with special provisions designed to allow reasonable freedom for the expansion of British businesses which carry on part of their operations abroad; and it should also be given some supervisory power over the investment beyond a certain sum of company reserves, especially in connection with the use of sums allocated for this purpose out of Excess Profits Tax.

Investment and Consumption.—It is sometimes argued that the results aimed at in this section could be better secured by State action to stimulate consumption directly, rather than indirectly by maintaining the volume of investment. The emphasis here laid upon investment in capital goods must not be taken as excluding measures designed to maintain the level of consumption. Excellent stabilising effects are to be looked for from a system of social security, both in keeping up a continuous flow of expenditure to meet the needs of those outside the working age or disabled or sick, and in accumulating contributions in periods of prosperity to be paid out for spending by the unemployed in periods of depression. It will be agreed that it is better to pay those who are available for useful work, wherever possible, for producing rather than for doing nothing; and measures designed to stimulate investment are indispensable to this end. But it is clearly wrong policy to attempt to meet the cost of such investment out of higher taxation, as this is bound to react adversely on consuming power. There is an overwhelming case for lowering, rather than increasing, the burden of taxation in times of economic difficulty.

Economic Development

What has been said in the preceding section implies that the Government will need, in the post-war period, to assume a much wider responsibility than in the past both for maintaining the general level of economic activity and for guiding the course of economic development. In other words, there will have to be a measure of economic planning, under the central direction of the Government.

The Location of Industry.—Cardinal importance attaches to the adoption of effective measures to influence and control the location of industry in the post-war period, both as a necessary element in town and country planning and as a means of avoiding the unnecessary piling up of industry in areas which are already congested and its corollary, the leaving derelict of other areas, with disastrous effects on community life and great avoidable waste of accumulated social assets. It is generally regarded as a good thing for areas to possess as diversified an industrial make-up as can be made consistent with efficient production; and with this object it is entirely justifiable for the State to restrict economic development, or particular kinds of development, in some parts of the country, while offering positive inducements to industrialists to settle in areas in which industrial growth will have desirable economic and social effects. In particular, the wider establishment of industrial estates, on the lines of the pre-war trading estates in the special areas, seems to be called for, and measures should be worked out for making it easy for new businesses, or businesses transferred from congested areas, to establish themselves upon such estates, which should, of course, be equipped with ample service facilities and might in suitable cases be based upon the great establishments which have been created during the war for the mass production of armaments. Nothing must be done to force firms to set up factories in areas which are economically unsuitable, or would involve high costs of production; and no rigid or inviolable limit should be set to the natural development in the more prosperous areas of the industries for which they are best suited. But inducements on the lines suggested can be legitimately offered as part of a concerted policy of avoiding urban congestion and reducing the need for large-scale migration of populations from areas threatened with a contraction of their established industries.

The Transition from War to Peace.—In what has been said so far this section has been dealing with questions of permanent public policy, and consideration has been given to measures which may be regarded as suitable for permanent adoption. It is clear, however, that in the period of transition from war to peace there will arise a number of special problems which will have to be dealt with by emergency measures or by the continuance for the time being of forms of public control which have been in force during the war.

In particular, it is evident that both the national and the international situation which will exist at the end of the war will make necessary a continuance for some time of a large measure of State control, both in order to enable Great Britain to play its due part in schemes of international relief and reconstruction and in order to secure an orderly change-over from war to peace output and a reasonable allocation of available supplies and means of production.

It is clear that many of the forms of control developed under war conditions are highly unsuitable for the promotion of economic efficiency in time of peace. Such controls as are designed mainly for the rationing of limited supplies of materials to essential uses will be no longer necessary, or will need to change their fundamental character, as scarcity of this or that type of material ceases to exist. It has, of course, to be recognised that international trade conditions may cause some limitation in the supply of certain imported commodities even when sheer physical scarcity is no longer present, and it may be necessary to take special steps for the control and distribution of such imports as remain scarce in this sense. But such cases should speedily become exceptional, and it should be an object of public policy to release industry as soon as possible from the mass of unproductive work which is involved in compliance with wartime regulations. Such controls as persist on a long-term basis should be simple in their operation, and should involve a minimum of form filling and of complicated dealings with a number of Government Departments and agencies.

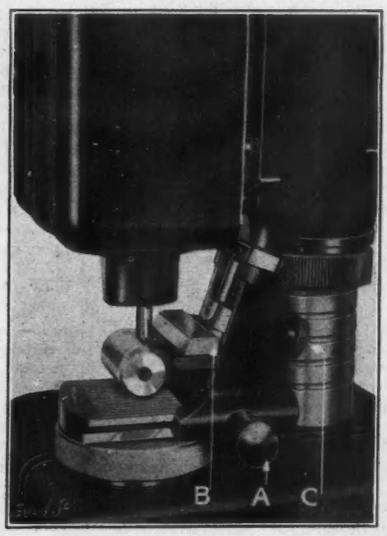
(*To be continued*)

Attachments for the Sigma Comparator

Two new attachments for the "Sigma" vertical mechanical comparator—fully described in THE ENGINEER of November 29th, 1940—have recently been introduced by the sole agents for "Sigma" products, E. H. Jones (Machine Tools), Ltd., Edgware Road, The Hyde, London, N.W.9. The first of these is a work locating stop. This adjustable locating stop is designed to facilitate locating cylindrical jobs under the contact pointer of the "Sigma" comparator, and whilst it is not designed or recommended for measuring super-accurate work, it is nevertheless being found of great assistance for locating the many types of mass-produced cylindrical components which have to be inspected to ordinary commercial limits. The first illustration shows how the unit fits to the standard work table of the comparator, where it is located in position by a large knurled screw A, which tightens up the twin slides of the unit against the tapered side face of the table. A hardened vee jaw B is securely fixed to its carrier by three screws and is easily removable as and when required. The carrier itself slides on twin hardened inclined columns and is locked in position by the knurled screw C. In practice the vee jaw of the work locating stop is first set to the required diameter of the work-piece by means of a standard gauge and on this

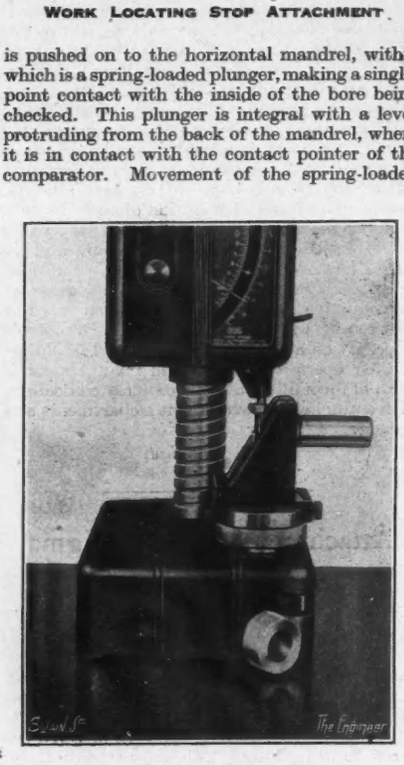
unit cylindrical work up to 6in. maximum diameter can be accommodated.

The second attachment, which is designed to facilitate checking the diameters of internal bores, is illustrated by the second engraving. It is held against the tapered side faces of the standard table by three knurled screws. The job to be checked



WORK LOCATING STOP ATTACHMENT

is pushed on to the horizontal mandrel, within which is a spring-loaded plunger, making a single-point contact with the inside of the bore being checked. This plunger is integral with a lever protruding from the back of the mandrel, where it is in contact with the contact pointer of the comparator. Movement of the spring-loaded



ATTACHMENT FOR CHECKING INTERNAL BORES

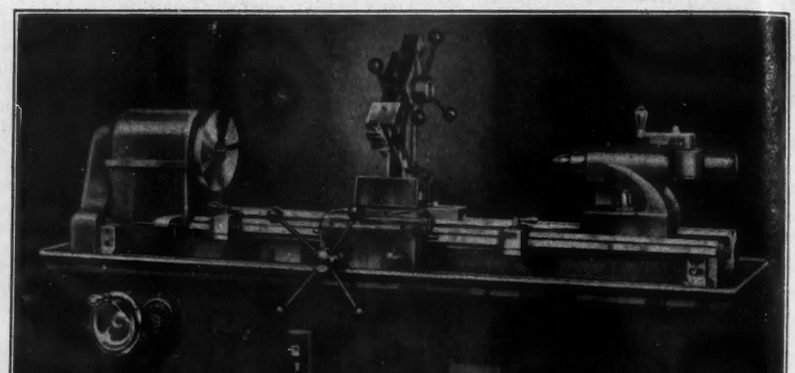
plunger is reproduced on the lever and the result of the check is shown on the scale of the comparator so that variations in diameter and also ovality can readily be seen and measured. Bores down to $\frac{1}{16}$in. are now being successfully checked with this set-up.

Super-Finishing Machine

SUPER-FINISHING is superimposed on any other form of metal finish and is effected by the use of abrasive blocks at low speeds with low unit pressure and adequate lubrication. It is claimed for it that it "removes the amorphous or non-crystalline surface of the material which is inevitably left by any dimensioning operation," and thereby eliminates practically all surface defects and exposes the true crystalline surface. The material removed amounts to no more than millionths of an inch.

The method was developed by the Chrysler Corporation for motor-car work, and a special machine for applying it was got out by the Ohio Units Manufacturers, of Dayton, Ohio, for whom the Broadway Engineering Company, Ltd., Carlisle Road, Hendon, N.W.9, are the agents in this country.

The latest form of this machine is shown in



SUPER-FINISHING MACHINE

the accompanying illustration. The abrasive blocks, two in number, are held in the inclined head, which is mounted on a traversing carriage. The pressure of the stones against the work is controlled by a spring adjusting device. The lowest spindle speed is 46 r.p.m. and the highest 619 r.p.m., or 72 r.p.m. and 935 r.p.m., depending on the speed of the motor fitted. The motor is quite small, usually about $\frac{1}{3}$ H.P. Various special fitments are available. The capacity is 48in. between centres with 11$\frac{1}{16}$in. swing over the carriage. The maximum distance between centres is 48in. It is worth adding that the base is of welded steel construction.

Alloy Steel Direction

A NEW Direction has been issued by the Controller of Iron and Steel to all alloy steel ingot makers, and it is obtainable from the British Standards Institution (price 6d. per copy, six copies or more 3d. each), 28, Victoria Street, Westminster, S.W.1. The object of the Direction is to conserve alloys. The main reason for this is the enormous increase in the demand for alloy steel, which means that available supplies of alloying elements now have to be spread over a bigger tonnage of steel. Whilst the effect of this Direction is to limit the number of compositions available, it is emphasised that the permitted compositions chosen are, for the most part, practically all steels which have been made for a considerable time and behind the manufacture and use of which is a wealth of experience. For simplification the basis of the new Direction, like that of the old, consists of a table showing which steels are permitted for any given range of tensile strength and size. This table shows the steels of the most economical alloy content which will give the desired properties, but obviously maximum alloy economy will not be achieved unless users take care not to call for physical properties in excess of the minimum which will give satisfactory service. The same remarks apply to size. For maximum alloy economy heat treatment should be carried out at the latest possible stage in the production of any component, when the ruling section is at its smallest. This applies particularly to components which are bored, as the ruling section is then less than in the solid form and steel of lower alloy content will give the same physical properties.

Among the permitted steels is a new specification En. 100, which is a low-nickel-chrome-molybdenum steel, which should be used to the fullest extent, as it can be made entirely from scrap and is therefore particularly economical in alloy usage. Besides En. 100 there are two other new En. Specifications to which attention is drawn, *i.e.*, En. 101 and 102. These are carbon-manganese steels containing no critical alloys, so are not covered by the Direction and may be used freely. They are steels having physical properties for which alloy steel has generally been used hitherto and should find a wide application.

The new Direction is restrictive only in respect of alloy steels, as it is hoped that both steel makers and users will exploit carbon steels to the fullest extent. There is much scope for the use of such materials where alloy steels have been previously used, especially if some relaxation in Izod value and ductility can be allowed.

BLASTING THE RIPPLE ROCK.—After almost a year of preparation, work is to start shortly on the removal of the Ripple Rock, long a serious navigation hazard in the Seymour Narrows at the entrance to Vancouver harbour. The drilling and blasting of the rock will be carried out from a 150ft. drill barge which is being specially built for the job. The work will be continued until the rock is removed to a depth of 35ft. below low water. The Ripple Rock actually comprises two rocks, the larger being 350ft. square and the smaller 150ft. square. The barge will be held in position during the work by six concrete anchors lying in the 300ft. deep bed of the Seymour Narrows. Two of the smaller 100-ton anchors have already been placed and one of the larger ones, weighing more than 200 tons, is now being made on a barge alongside the drill barge. It is expected that 1200 drillings will be necessary.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

The Disposal of Surplus

Amongst the post-war problems that will have to be met, and to which business men are giving great consideration, is the disposal of surplus material. At the end of every modern war enormous quantities of stores of various descriptions which have been accumulated for the prosecution of hostilities have to be dealt with, and the problem is to dispose of them without disturbing the trades and industries which handle them under normal peacetime conditions. In the last war the Government set up a Disposals Board, but some of the industries attributed in some measure the slump that followed in the early 'twenties to the enormous amount of surplus material which was being sold in competition with new production. Many trade organisations have studied the problem and a short time ago the London Chamber of Commerce circulated a plan for the disposal of surplus after the present war. For these reasons the announcement that a company has been registered, entitled Iron and Steel Disposals, Ltd., has aroused more than ordinary interest. The official statement says that the company was "formed at the instance of the Ministry of Supply to enable surplus stocks to be acquired and re-distributed for use for more essential purposes." No dividend is to be paid or distribution of assets made prior to the winding-up of the company, and all profits which would, but for this provision, be divisible among the members are to be handed to the Ministry of Supply. The company is apparently being formed by the steel industry, and it would seem that the steel makers have been the first off the mark to take concrete steps to handle the surplus. The details which have been filed give the registered office of the new company as Steel House, Tothill Street, Westminster, S.W.1, the London headquarters of the steel industry and also the London address of the Iron and Steel Control, as well as of the British Iron and Steel Federation and the British Iron and Steel Corporation. The capital of the company is £1000 in shares of £1 each. The subscribers (one share each) are Mr. D. M. Forbes, 106, Shaftesbury Avenue, W.1, solicitor; and Mr. E. Edwards, 25, Stockfield Road, S.W.16, solicitor's manager. No return of allotments or list of directors has been filed. The first directors are to be appointed by the subscribers. It is stated that a director need not be a shareholder and that directors' remuneration is to be fixed by the company. The objects of the company, as registered, include the following:—"To enter into an agreement with the Ministry of Supply to acquire stocks and dispose of iron and steel in any form (and particularly surplus stocks thereof) and any other materials, metals, minerals, substances, and products which can be conveniently dealt with by the company; to acquire, improve, and develop stockyards or land and premises suitable therefor, for the sorting, treatment, and manipulation of iron and steel material and products; to carry on the business of iron, steel, and metal merchants, bell founders, demolition contractors, dismantlers and removers, toolmakers, metal works, smiths, manufacturers of and dealers in tools, hardware, missiles, arms, and weapons (warlike and sporting), manufacturers and factors of and dealers in locomotives, railway carriages, wagons, tramcars, and rolling stock, motor-cars, vehicles and aircraft, general engineers, boilermakers, shipowners, shipwrights, shipbreakers, carriers, &c." By which it may be assumed that the company proposes to handle many more materials than merely iron and steel.

New Bolt and Nut Prices

Alterations in the present controlled maximum prices of certain types of bolts and nuts are contained in a new Order issued by the Minister of Supply. The price list has also been extended to cover some types of aircraft bolts and nuts. Copies of the Order, the Control of Bolts, Nuts, Screws, Screw Studs, Washers and Rivets (No. 2) Order, 1943, which came into force on July 1st, may be obtained from H.M. Stationery Office, York House, Kingsway, W.C.2, or through any bookseller, price 1d.

The Pig Iron Market

Generally speaking, the pig iron position is satisfactory and is likely to become more so as a result of the arrival of high-grade ore from North Africa. This should lead to an increase in the production of hematite and refined pig iron, of which there has been a stringency for a long time. All the consuming industries are busy and are fully employed upon war work. The heavy engineers and the machine tools foundries are particularly well employed, and most of the jobbing foundries have as much work as they are able to undertake. There is a huge demand for castings which are wanted in increasing quantities for armaments, including tanks and gun parts and for motor vehicles. The practice of many foundries has changed considerably during the war and the scarcity of hematite, medium and low-phosphoric pig irons has resulted in the adaptation of their products to the use of substitutes. The light castings foundries which are the principal users of high-phosphoric pig iron are poorly employed, although many more of them are now producing castings for the engineering industry. It has been necessary for these foundries to adapt their plant before they could serve a useful purpose in the war effort, but this reorganisation has been largely completed now, and many of the foundries are in a much better position so far as employment is concerned. Although the prospects in the hematite and low-phosphoric pig iron departments have improved with the arrivals of high-grade ore, it will be some little time before this is reflected in much easier conditions in the market, but when larger supplies of hematite are available it will affect the whole pig iron position, since there will be a lesser demand for the irons which have been used to such a large extent as substitutes. The demand for high-phosphoric pig iron is steady, but supplies are available in liberal quantities. This description of pig iron is used for a number of purposes, for which before the war it was not considered suitable, but the light castings industry, although taking more of this iron than was the case a short time ago, is not consuming anything like the quantities used in pre-war days. The demand for basic pig iron from the steel industry is maintained at a high level, but there is no shortage and deliveries are regular and fully cover consumers' needs. There is a moderate, although steady, business passing in forge iron, but no tightness is noticeable in supplies of this material.

The Midlands and South Wales

The Midland iron and steel industry is in full operation, and the situation shows little change from that which has ruled for some months. Some change has taken place here and there in the incidence of the demand, but for the most part all the departments are experiencing heavy pressure from consumers. The demand for plates is unrelaxed and shipbuilders, locomotive builders, and tank and boilermakers are, together, taking a large aggregate tonnage. Considerable quantities of sheets are also going to the shipyards. A large volume of business is passing in light sectional material, and recently, delivery dates have become extended. On the other hand, there is not more than a moderate call for heavy joists and sections, and consumers can obtain these descriptions for fairly near delivery. The demand for bars seems to have increased of late, and there is an important business passing in the large sizes. The engineering industry is taking big quantities, whilst the production of small bars by the re-rollers is on a heavy scale. The present demand for small structural shapes is keeping the producing works fully employed, and the full output of these materials goes quickly into consumption. The makers of bar iron are meeting with a stronger demand than a short time ago, but the consumption of this class of material is much less than of steel. Most of the works could take on more business than they have on hand, but there is a steady trade passing in best bars and crown iron. There is a fairly good request for Nos. 3 and 4 bars. Producers of iron and steel in South Wales have as much as they can do to meet the heavy demand, which covers practically all descriptions. Consumers have recently been trying to make sure of filling their requirements for the third delivery period, and most of the manufacturers have taken on as much work for that period as they can undertake. The tinplate market remains dull, although recently more business has been transacted in both the home and export departments. The home trade, however, has barely maintained the activity which developed about ten days ago. On the export side of the industry more licences appear to have been granted than recently, but the amount of overseas business actually transacted has been on a restricted scale. There has been a sharp improvement in the demand for black plates and a fair amount of business has passed. The sheet industry is uniformly busy and makers are fully committed for the third quarter of the year.

The North-East Coast and Yorkshire

The production of steel on the North-East Coast has been maintained at a high level, and, according to reports, records have at times been broken, but, of course, figures of production have not been published since the war, so that the reports current must be accepted with reserve. After the war it will be interesting to learn how heavy was production in this district. All the works are operating at capacity and delivery dates have been kept in the majority of cases during the current delivery period. It is thought that there will be few cancellations of contracts under the rule that all uncompleted contracts that are six months old are cancelled unless they are granted special authorisation by the Control. Practically the whole of the production goes to meet the requirements of the war industries, and the great attention that has been paid to maintain the supplies of fuel, scrap, limestone, and ironstone has materially contributed to the big production. Liberal supplies of coke are obtainable, and some of the consuming works have had to suspend deliveries recently. The semi-finished steel position is satisfactory, more so than it was hoped a few weeks ago. Good supplies of billets and sheet bars are being received from the home producing works, and, in particular, recently there has been a considerable increase in the quantities reaching consumers from Welsh works. Re-rollers are fully employed, and their requirements of billets are on a heavy scale. They are, however, receiving substantial allocations, and the outlook is satisfactory. The re-rolling industry, besides rolling big tonnages of steel bars and strip, are turning out a heavy tonnage of light and special sections, and in some cases are also contributing to the manufacture of colliery steel. The demand for plates has not diminished, whilst although there has been some easing in consumers' pressure to obtain sheets, the works have a large amount of work on hand, much of it to meet Service requirements. A comparatively poor demand for heavy joists, angles, and sections is noticeable, and these sizes can be obtained for fairly near delivery. On the other hand, longer periods are required for deliveries of light and medium sections. The Yorkshire steel works continue to operate under strong pressure. The heavy demand for alloy steels has been met in a large measure by increased production, but the requirements of the aircraft and armaments manufacturers are on a heavy scale. The decline in the demand for alloy steels, however, is principally confined to the more expensive types. The whole production of acid carbon steel is quickly taken up, and basic steel makers are kept fully employed in meeting the war demand.

Scotland and the North

The Scottish steel works are fully engaged and the recent rush of orders following allocations for Period III has practically filled their order books for the next three months. In some cases they have orders in hand for delivery in the first period of next year. All the consuming trades also are busy, and their demand upon the iron and steel industry reaches a high total tonnage. The Scottish re-rolling industry is working practically at capacity, and is turning out large quantities of small steel bars, structural steel, and strip. It is fortunate for this branch of the industry that supplies of semis have increased of late and have removed the feeling of concern that was noticeable recently, owing to the heavy withdrawals which had been made upon stocks of imported material. Fresh imports from the United States and increased production from home works have made the position secure. Naturally, great interest is being taken in the course of the coal strike in America and its effect upon the steel industry, since it may reduce the quantities of steel reaching this country. In addition to the ordinary qualities of billets, quantities of double-sawn crops, defective billets, and shell discards are being used. There is an active business passing in structural steel. Heavy joists, angles, and sections are obtainable comparatively easily, but there is a strong request for the lighter sizes, and delivery dates are becoming rather extended. There has been no diminution in the demand for plates and the producing works are operating under heavy pressure. All the sheet works are busy, and much of the business in hand consists of orders on Government account. The shipbuilders also have placed important contracts. Active conditions rule in the Lancashire iron and steel market. Apart from the persistent and heavy demand for plates, there is a strong request for steel bars, particularly the large-diameter bars, and some works are so full up with orders that they have declined fresh business. There is an active trade passing in bright steel and the producing works have some arrears of work in hand. The demand for alloy steel is outstanding, and the production is passing largely to the aircraft, motor vehicle, and engineering industries. There has been no change for a long time in the conditions ruling on the North-West Coast. The steel works are experiencing an insistent demand and are operating at capacity.

Notes and Memoranda

Rail and Road

WHAT WAR TRAFFIC MEANS TO THE RAILWAYS.—Apart from passenger traffic, the London Midland and Scottish Railway Company increased its loaded wagon mileage in 1942 to 1713 millions, or 82½ millions more than in 1941. Some 390,000 wagons are used every week and its locomotives hauling freight trains covered 121 million miles last year, an increase of over 3½ millions over 1941 and nearly 19 million miles more than in 1938.

FROM CEMENT TO PETROLEUM.—An American transport concern has converted some of its lorries from cement carriers to "gondolas" with five steel containers, each holding 1750 gallons of petroleum, or a total of 8750 gallons per car. Other cars, fitted with six containers, each holding 1695 gallons, have a total capacity of 10,170 gallons. Up to the time of conversion, which was completed recently, these cars had been used in cement traffic for five years.

THE ALCAN HIGHWAY.—At least thirty-five major bridges, 90 per cent. of them of steel construction, are to be built along the Alcan Highway this year. Some of them will be several hundred feet in length. Meantime, Fort Smith, on the Slave River, has become the port for loading oil pipes for an 800-mile barge voyage along Canadian rivers and lakes to the Fort Norman oil wells. United States Army engineers are carrying out this "Canal Project" covering more than 1500 miles in the frontier country of Northern Canada, to facilitate the transportation of oil for use on the Alaska-Canada defence road system. The pipe line will carry oil from the Fort Norman oilfields across the mountains to Whitehorse.

SWISS RAILWAY PROBLEMS.—The war has provided Swiss railwaymen with problems in securing materials for the maintenance of their equipment and right-of-way. From 60 to 120 tons of lubricants per month are required for the Government-operated railways. Since early in 1940 stocks of this material have been very low. In 1939 steel rails could still be imported. However, in 1940 and 1941 this was no longer possible. The requirements of the Swiss railways are 12,000 to 15,000 tons of rails per annum. In the past few months they have been able to import a few hundred tons; meanwhile they have had to draw on their reserves. The situation with regard to metal sleepers presents similar difficulties, imports having stopped altogether in 1939. Track maintenance has therefore suffered. As a compensatory measure, road beds have been given extra care and trains have been decelerated to prevent accidents.

Air and Water

THE NEXT U.S.A. SHIPS.—Contracts for the construction of 460 merchant ships, including 220 newly designed "Victory" ships, have been awarded by the United States Maritime Commission. The "Victory" ships, slightly larger and faster, will eventually replace the "Liberty" type ship which the Commission has been building by the hundreds. The contracts for the new ships were divided between four yards. In addition, the Commission awarded a contract for twenty-eight tankers to a fifth company.

U.S.A. SHIPBUILDING.—The United States Maritime Commission reports that the United States shipbuilding industry in 1942 broke every world record for volume of shipbuilding, turning out a total of 8,090,800 deadweight tons of merchant shipping. The 1942 total includes 542 "Liberty" type vessels, 62 tankers, 5 ore carriers, 62 long-range "C" type ships, 55 cargo carriers for Great Britain, 5 coastwise ships, and 15 special type craft. In addition, some 800 smaller craft and other vessels were delivered to the Army and Navy. The goal set for 1943 is 19,000,000 deadweight tons.

A FAMOUS HYDRAULIC ENGINEER DIES.—The close connection between water power and the production of aluminium is revealed in the obituary notices of Mr. James W. Rickey, former chief hydraulic engineer of the Aluminum Company of America, who has died in Washington, D.C., at the age of seventy-one. Born at Dayton, Ohio, Mr. Rickey graduated in 1894 from the Rensselaer Polytechnic Institute, Troy, N.Y., as a civil engineer. From 1897 to 1907 he was principal assistant engineer for the St. Anthony Falls Power Company and the Minneapolis Mill Company, and in 1907 was engaged by the Aluminum Company of America as chief hydraulic engineer. For the next thirty years he designed and supervised the building of all the company's dams and was responsible for many important hydro-electric developments. Since his retirement in 1937 he had been consulting engineer to the company.

BOATBUILDING IN INLAND YARDS.—Building small craft miles away from the seaboard may have advantages, but is apt to create curious transport problems. Two Canadian National flat railway cars were needed to ship a 60ft. tugboat weighing 47 tons to an Eastern Canadian port. The boat had to be shipped on its side and there was one bridge under which it went with only 1in. to spare.

CHICAGO TURNS TO SHIPBUILDING.—The Pullman-Standard Car Manufacturing Company has launched the first of a new design of naval patrol vessel and the first ocean-going patrol craft ever built in Chicago. About 180ft. long and designated a PCE (patrol craft escort) by the Navy, it has been built for unlimited ocean service and will be equipped for anti-submarine warfare. The boats are constructed in fourteen sections, each completed on systems of jigs. The sections are then moved from the plant to the launching ways 4 miles away. The building ways accommodate twelve vessels at one time. Each finished craft is launched sideways.

BLUE PRINTS BY AIRGRAPH.—By permission of the G.P.O., blue prints are now being sent by airgraph in two ways to Dunlop factories in India, South Africa, and Canada. The drawings may be made on the airgraph form itself, 8½in. by 10½in., reduced to a size smaller than a halfpenny stamp, for transport by aeroplane, and then enlarged on arrival to half their original size. Alternatively, the original drawing is reduced to airgraph letter size, sent off by airgraph, and brought up to normal size on receipt. The airgraphs go out in about one-third of the time taken by boat and the risk of loss is almost negligible. Should the aeroplane be shot down, duplicate prints follow the first set. The chances of leakage of information are also much less when drawings are sent by air.

Miscellanea

A NEW USE FOR ANTHRACITE.—Reports from the United States suggest that anthracite coal has proved more efficient than sand for clarifying water supplies.

SPEEDING UP GEAR PRODUCTION.—The methods by which 320 bevel pinion gears per hour are produced with a press, replacing nineteen generating machines, were explained in a lecture by Mr. R. J. Goldie, of the Timken-Detroit Axle Company. The gears are hot forged to finished shape from steel blanks, the only major machining operation required being the drilling and reaming of the bore and the back face. The gear teeth, even after heat treatment, are claimed to be accurate to the thousandth of an inch.

THE I.E.E. AND PRISONERS OF WAR.—In collaboration with the British Red Cross Society, arrangements were made by the Institution of Electrical Engineers for British prisoners of war in Germany to sit for the associate membership examinations held in May and November, 1942. There were nineteen such candidates who took the examination, or parts thereof, on one or other of the two dates, seven of whom were successful in passing Parts I and II, three in passing Part I only, and one Part II only. Five others passed in single subjects, a special concession having been granted to prisoners of war to take one subject at a time if they so desired. It is gratifying to record that a commendably high standard of marks was reached by the candidates. Seventeen further candidates in Germany entered for the May, 1943, examination.

PRODUCTION AUTHORITIES GUIDE.—The Ministry of Production has produced a Guide which shows at a glance which is the authority responsible for the production of manufactured products that are not obviously the concern of a single Government Department. Neither industry nor Departments have any difficulty in knowing, for instance, that tanks are the responsibility of the Ministry of Supply and aero-engines of the Ministry of Aircraft Production; but between such well-defined classes of munitions is a vast number of products which, because they are used in a great variety of finished articles or for many different purposes, are common to more than one Department. These common products include, for instance, agricultural machinery, anti-gas equipment, benzol, bicycles, ball bearings, bolts, nuts and screws, cement, clothing and footwear, locomotives, pencils, tobacco, and tyres. This "Production Authorities Guide" contains a list of 194 products, the production authorities responsible for each, and other details, such as whether the control is exercised by Order or whether there is an Advisory Trade Panel. It has been printed for the Ministry by the Stationery Office, price 4d. It deals only with manufactured products. Raw materials are dealt with in the "Raw Materials Guide," issued by the Ministry of Supply and also published by the Stationery Office, price 1s. 2d. post free.

CANADA'S SEARCH FOR NEW METALS.—New deposits and new processes, discoveries by the prospector and the scientist, are helping Canada to fill some of the gaps in the production of strategic minerals needed in the war. One of the most important developments is the production of mercury in British Columbia. Before the war Canada produced no mercury. To-day she is one of the world's largest producers, with an output about six times her own requirements. A second metal is tungsten. When the supply from China was shut off by Japan, Canada looked around, and last year the production rose by 17 per cent., with 1943 promising an even greater increase. Until a few months ago Canada had no production of magnesium. A plan now using the ferro-silicon process developed by a Canadian, Dr. Pidgeon, is supplying more than her own needs and she is already exporting to Great Britain.

Personal and Business

DR. A. C. PEPPER has been appointed a director of Alexander Duckham and Co., Ltd.

MR. C. A. SUTCLIFFE has been appointed supply engineer, Metropolitan Water Board.

MR. E. L. DENNY has been appointed a director of William Denny and Brothers, Ltd., Dumbarton.

MR. W. T. TOLHURST has been appointed to the vacancy on the board of W. G. Allen and Sons (Tipton), Ltd., caused by the recent death of Mr. W. H. Hand.

MR. J. MACDONALD SMITH, formerly transport and engineering manager of the United Africa Company, Ltd., in West Africa, has joined the board of Porn and Dunwoody, Ltd., Bear Gardens, S.E.1.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

Association of Austrian Engineers, Chemists, and Scientific Workers in Great Britain

Monday, July 12th.—Inst. of Structural Engineers, 11, Upper Belgrave Street, S.W.1. "Economical and Technical Reconstruction in Central Europe," M. F. Nemec. 7.15 p.m.

Association of Building Technicians

Thursday, July 15th.—Alliance Hall, Palmer Street, Westminster, S.W.1. "Concrete," O. Arup. 7 p.m.

British Standards Institution

Tuesday, July 20th.—Connaught Rooms, Great Queen Street, Kingsway, W.C.2. Annual general meeting. 3 p.m.

Building Industries National Council

Wednesday and Thursday, July 21st and 22nd.—Central Hall, Westminster, S.W.1. Building Congress. 10 a.m. each day.

Institute of Fuel

Wednesday, July 21st.—James Watt Memorial Institute, Great Charles Street, Birmingham. "Radiant Heat for Industrial Processes: 'Infra-red' by Gas," L. W. Andrew and E. A. C. Chamberlain. 2.30 p.m.

Institute of Industrial Administration

Friday, July 30th.—Livingstone Hall, Broadway, Westminster, S.W.1. Management Brains Trust. 6.45 p.m.

Institute of Marine Engineers

Tuesday, July 13th.—85–88, Minories, E.C.3. "Whither Coal?" G. B. Baird. 5.30 p.m.

Institute of Physics

Saturday, July 10th.—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. Discussion opened by D. E. Thomas. 2.30 p.m.

Institution of Electrical Engineers

Saturday, July 10th.—LONDON STUDENTS' SECTION: Visit to Johnson and Phillips, Ltd. 2.30 p.m.

Royal Aeronautical Society

Wednesday, July 14th.—GRADUATES' SECTION: 4, Hamilton Place, W.1. "Surface Finishing of Components," J. A. Oates. 7.30 p.m.

Friday, July 23rd.—Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. "Education and Training of Aeronautical Engineers." 5.30 p.m.